NASA-TM-84415

Research and Technology Objectives and Plans

SUMMARY

NASA
National Aeronautics and Space Administration

FISCAL YEAR 1982 RESEARCH AND TECHNOLOGY PROGRAM

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, at the price code A09 ($16.50 domestic; $33.00 foreign).

INTRODUCTION

This publication represents the NASA Research and Technology program for FY 1982. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The *RTOP Summary* is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. We believe also that this publication can help to expedite the technology transfer process.

The *RTOP Summary* is arranged in five sections. The first section contains citations and abstracts of the RTOPs. Following this section are four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

The Subject Index is an alphabetical listing of the main subject headings by which the RTOPs have been identified.

The Technical Monitor Index is an alphabetical listing of the names of individuals responsible for the RTOP.

The Responsible NASA Organization Index is an alphabetical listing of the NASA organizations which developed the RTOPs contained in the Journal.

The RTOP Number Index provides a cross-index from the RTOP number assigned by the NASA responsible organization to the corresponding accession number assigned sequentially to the RTOPs in *RTOP Summary*.

As indicated above, responsible technical monitors are listed on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contact which might be disruptive to ongoing research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the *RTOP Summary* would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration
Office of Aeronautics and Space Technology
Washington, D.C. 20546
Attn: William P. Peterson, Director
Resources and Management Systems Division (RM-3)

Jack L. Kerrebrock
Associate Administrator for
Aeronautics and Space Technology

TABLE OF CONTENTS

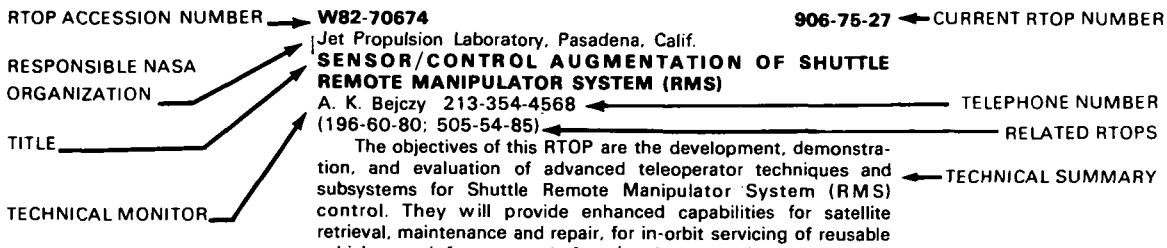
Office of Space Science

Office of Space Tracking and Data Systems

Office of Space Transportation Systems

Indexes

TYPICAL CITATION AND TECHNICAL SUMMARY



The objectives of this RTOP are the development, demonstration, and evaluation of advanced teleoperator techniques and subsystems for Shuttle Remote Manipulator System (RMS) control. They will provide enhanced capabilities for satellite retrieval, maintenance and repair, for in-orbit servicing of reusable vehicles, and for space platform/station assembly such as the Space Operations Center (SOC). The objectives include the development of proximity, force torque and contact sensors with related controls, integrated graphic displays of sensory information, bilateral force reflecting manual controls, and computer based voice command capabilities for controlling both TV cameras/monitors and graphic displays. The final objective is to demonstrate enhanced and smart sensor/control capabilities in the form of protoflight systems/experiments in the CY-84 to 86 time period. The specific FY-82 objectives are: (1) conduct and evaluate force torque control experiments at the JSC Manipulator Development Facility (MDF) using the force torque sensor and display system developed at JPL in FY-80/81; (2) produce both requirements definitions and preliminary designs for protoflight sensor, control, display, and voice command systems, including protoflight experiments definitions; (3) initiate component developments where appropriate. The technical approach is experimental and utilizes the testing capabilities of the JSC MDF. Appropriate sensors, control, displays, algorithms, and related microprocessor based data handling will be developed at JPL based on concepts previously demonstrated in the JPL teleoperator laboratory. New sensor/control capability demonstrations will be conducted using the full scale Shuttle mock up manipulator at the JSC MDF. Existing hardware and facility equipment at JSC will be utilized to the greatest extent possible. The experiments will be defined, performed and evaluated jointly with JSC personnel. The protoflight sensor/control systems/experiments definitions and development will also be done jointly with JSC.

RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS

a summary **FISCAL YEAR 1982**

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics Research and Technology Base

Aerodynamics Research and Technology

W82-70001 **505-31-01**
Ames Research Center, Moffett Field, Calif.
CLASS VI COMPUTATIONAL CAPABILITY SUPPORT
M. C. Smith 415-965-5188

The objective is to provide the research community at Ames with state of the art computational tools which will enable the researchers, particularly in the computational physics community, to maintain their preeminence. This will be accomplished through a contract which provides total computational capability including all components of the computer systems, as well as design, development, maintenance, and operational, functions.

W82-70002 **505-31-10**
National Aeronautics and Space Administration, Washington, D.C.
ADVANCED GEOMETRIC MODELING AND GRID GENERATION
Randolph A. Graves, Jr. 202-755-3280
(505-31-11; 505-31-13)

The objective of this program is to focus attention on the pacing items in the applications of advanced computational fluid dynamic analyses to complex geometric configurations. Grid generation was identified as the key pacing item in computational aerodynamics. Since grid generation is intimately tied to surface geometry then the geometric modeling of complex aircraft/missile configurations must be an integral part of any grid generation technique. This program seeks to identify critical problem areas in both surface geometric modeling and in grid generation and in addition, will attempt to identify possible solution avenues.

W82-70003 **505-31-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL METHODS AND APPLICATIONS IN FLUID DYNAMICS
V. L. Peterson 415-965-5265
(506-51-11; 506-51-41; 505-31-91)

The overall objective is to develop the capability for predicting complete aerodynamic characteristics of given aircraft shapes and designing new configurations aerodynamically optimized for specific missions to a degree that preliminary concepts can be developed, evaluated, and screened with less time, cost, and wind tunnel tests. New mathematical methods, languages, and compilers will be constructed to realize the most effective use of available computer resources. Computer programs will be developed to simulate turbulence and to solve complex fluid dynamics problems for the complete spectrum of flight speeds, from low subsonic, transonic, to hypersonic, and for steady and unsteady, inviscid, and viscous flow over two and three dimensional configurations. Fundamental experiments will be performed to verify these codes and to provide the necessary turbulence models. The Reynolds number domain will extend from conventional wind tunnel conditions to full scale flight conditions for present and future aircraft. The timely transfer of advanced computational aerodynamics technology to the aerospace community will be implemented by developing and disseminating computer codes applicable to practical aerodynamics problems.

W82-70004 **505-31-13**
Langley Research Center, Hampton, Va.
COMPUTATIONAL FLUID DYNAMICS
J. C. South, Jr. 804-827-2627
(534-02-13; 505-31-33; 505-31-23; 514-55-03)

The purpose of this research is to provide the fundamental computational methods required for calculating complete aerodynamic characteristics of complex aircraft shapes and for optimizing aircraft shapes for a given mission. The primary emphasis will be basic research in numerical and anaytical methods coupled with large scale computers. Most computer codes developed in this plan will be of the 'pilot code' class; when a method or code is proven as a useful preliminary tool, further developments of the codes for more complex configurations will be supported by RTOPs which are applications oriented, such as ACEE and EET. Research includes viscous and inviscid flow methods for all speed ranges, with near term emphasis on the subsonic transonic range. The main interest is in large, nonlinear problems; studies include acceleration of iterative methods for large systems of finite difference equations, mesh generation methods, turbulence modeling, and algorithms suitable for vector processor computers such as CYBER 203 and CRAY.

W82-70005 **505-31-21**
Ames Research Center, Moffett Field, Calif.
TURBULENCE AND MODELING
C. Thomas Snyder 415-965-5066
(505-31-51; 505-31-31; 505-31-41)

The objective is to conduct analytical and experimental studies into complex turbulent flow fields. Specifically, turbulent flows interacting with shock waves, turbulence structure in low speed separated flow around airfoils, and turbulence associated with the flow around highly curved surfaces and general three dimensional surfaces are considered. Emphasis is placed on obtaining detailed and accurate experimental data that can be used to guide the development of mathematical models for turbulent structures. These mathematical models will subsequently be used to develop fast, efficient methods for the prediction of both attached and separated turbulent flows.

W82-70006 **505-31-23**
Langley Research Center, Hampton, Va.
TURBULENT DRAG REDUCTION
D. M. Bushnell 804-827-4546

Research to significantly improve our ability to predict and control the behavior of turbulent shear flows including boundary layers, free shear layers, and recirculating/vortex flows will be conducted. Theoretical and experimental research to (a) reduce turbulent skin friction drag, (b) control stream disturbances in supersonic and hypersonic tunnels, (c) determine sensitivities of laminar boundary layer transition process to stream disturbances, and (d) improve understanding of physics/structure of turbulent shear flows and turbulence modeling for computational fluid dynamics will be performed. Drag reduction research investigates nonplanar geometries such as riblets and large eddy breakup devices, fuselage relaminarization, and ion wind concepts, primarily for eventual CTOL transport application. Free stream disturbance research develops stagnation chamber treatments and laminar flow and rapid expansion nozzles to improve validity of wind tunnel measurements, especially for data where transition and flow separation are present. Detailed boundary layer transition studies with controlled input disturbances determine sensitivity of transition process to operational factors such as engine noise and surface irregularities. Detailed experiments using hot wires, LV/Raman, Rayleigh scattering and resonant Doppler systems provide data for development and validation of turbulence closure models in three dimensional boundary layers, three dimensional free mixing, corner/recirculating/vortex flows and shock turbulence interaction/amplification.

W82-70007 **505-31-25**
Jet Propulsion Laboratory, Pasadena, Calif.
BOUNDARY-LAYER STABILITY AND TRANSITION RESEARCH
L. M. Mack 213-354-2138

Knowledge of where laminar turbulent transition will occur is important for accurate drag calculations, and a significant reduction in total drag is possible if transition can be delayed by passive or active means. At present it is not possible to make a rational prediction of if and where transition will occur because the relationship between transition and the disturbances that cause it is not known. It is the purpose of the work described in this RTOP to investigate experimentally and theoretically the production of instability waves by external disturbance sources (receptivity problem), and the propagation of the resultant wave packets and wave trains in the boundary layer. The experimental program consists of two parts. The first part, a receptivity experiment, will seek the mechanisms by which instability waves are produced by freestream sound and turbulence, and relate the initial amplitudes and phases of the instability waves to the properties of the sources. The second part, a wave propagation experiment, will measure the wave trains and wave packets formed by continuous and pulsed line and point sources in planar and axisymmetric boundary layers. The theoretical program will be closely coordinated with the experiments. The point source initial value problems will be solved by the method of steepest descent as generalized by Gaster for growing boundary layers. Particular attention will be paid to the accurate calculation of wave amplitude. Gaster type series will be developed for each boundary layer studied to make it feasible to compute the very large numbers of eigenvalues that are needed to construct the wave patterns. The propagation of the normal modes produced by line sources will be calculated by locally parallel stability theory plus the nonconservative kinematic wave theory, and/or nonparallel stability theory. A model for the receptivity problem will be developed on the basis of the experimental findings. The long term objective is to combine the results of the receptivity and wave propagation investigations to arrive at a rational method for the prediction of transition.

W82-70008 **505-31-31**
Ames Research Center, Moffett Field, Calif.
AIRFOIL AND WING DEVELOPMENT
C. Thomas Synder 415-965-5066
(505-31-21; 505-31-41; 505-31-51)

The objective of this RTOP is to conduct research that will lead to the development of a technology base for the design of advanced airfoils and wings. The scope of the research encompasses both unsteady and steady flow about single element airfoils and steady flow about multi-element airfoils. The single element airfoil program has three main elements: (1) development of advanced computational codes for optimum airfoil design; (2) development of adaptive wall technology for airfoil and wing testing; and (3) theoretical and experimental study of transonic flow about oscillating airfoils. The high lift airfoil program is focused around coordinated experimental studies which will provide data required for guidance and verification of theoretical work toward the analysis of subsonic, viscous flow around multi-element airfoils, and the flow around wings that are equippd with high lift devices. Emphasis will be placed on merging turbulent shear layers, experimental studies of turbulent separated flows, and the analysis of three dimensional flow over finite wings equipped with leading edge flaps and trailing edge flaps.

W82-70009 **505-31-33**
Langley Research Center, Hampton, Va.
AIRFOIL DEVELOPMENT
Robert E. Bower 804-827-3285

The airfoil aerodynamics program is to provide analytical methods and computer codes coupled with experimental procedures and test facilities for the design and development of airfoils and airfoil systems in both steady and unsteady flows and to employ these tools in the development of advanced technology single and multielement airfoils for all classes of aircraft. The applications include propeller selections and airfoils for fixed and rotory wing aircraft and involve the subsonic and transonic speed regimes and laminar and turbulent boundary layers. The program includes: (1) the generation of precise theoretical and rapid engineering analysis and optimal design methods which were verified through appropriate selected experiments; (2) the development of new and improvement of existing airfoil research facilities to improve the range and validation of two dimensional data; and (3) the generation and documentation of the aerodynamic behavior of new families of airfoils, airfoil controls, and high lift systems by the use of both theory and experiment in support of U.S. industry and DOD to satisfy specific and special purpose airfoil needs.

W82-70010 **505-31-41**
Ames Research Center, Moffett Field, Calif.
AERODYNAMIC THEORY/EXPERIMENTAL INTEGRATION
L. L. Presley 415-965-5851
(505-43-11)

The objective of this research is to expand the aerodynamic technology base and provide a basic understanding of the aerodynamic flow fields about complete wing body tail configurations as well as individual components through the useful angle of attack range and from subsonic through supersonic Mach numbers. This is being accomplished in two ways: (1) the development of new theoretical methods; and (2) the integration of theory and experiment to yield a more complete understanding of the aerodynamic phenomena. The primary theoretical methods under development include a transonic wing body tail code using the full potential equations and an advanced linear panel code applicable to both subsonic and supersonic flow. In addition, methods will be developed to combine various calculation techniques to predict more complex flows, such as jet induced effects, or to numerically optimize aircraft components. The integration of theory and experiment includes the development of techniques to rapidly compared calculated and measured results and to integrate theoretical and experimental procedures to provide a more complete definition of the aerodynamic characteristics.

W82-70011 **505-31-43**
Langley Research Center, Hampton, Va.
CONFIGURATION AERODYNAMICS
R. W. Barnwell 804-827-2601
(534-02-13)

The technical objective of this research primarily is to increase the technology base for the development of practical means for improving the aerodynamic performance of high subsonic and

supersonic aircraft through the generation and application of an expanded experimental data base and the development and evaluation of improved theoretical and empirical design and analysis methods. The expansion of the experimental data base will be accomplished through parametric wind tunnel tests, guided by theoretical analyses with emphasis on favorable interference of multiple lifting surfaces, interacting vortex flows and vortex lift optimization, favorable interference lift by proper integration of the propulsion system with the airframe, development of improved high-aspect-ratio supercritical wing and wing-winglet configurations and efficient under-the-wing propulsion system installations supercritical flow, investigation of swept-forward wings and application of variable geometry concepts. Improved analysis methods for both attached flow and vortex flow concepts, critical aerodynamic and structural design conditions involving edge separation induced vortex flows will be developed. Further, theory and experiment will be used to investigate high lift systems for landing and takeoff and means for increasing the off design performance of configurations with high cruise efficiency.

W82-70012 **505-31-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AERONAUTICS FLIGHT EXPERIMENTS
L. C. Montoya 805-258-3311

The objective of this RTOP is to provide a continuing research and development effort into the problems associated with the fundamental understanding of fluid and flight mechanics with special emphasis on the relationship to large scale vehicles operating in a real world environment free of interference effects. These efforts include experimental aerodynamic studies to improve our ability to predict the efficiency of vehicles moving through the atmosphere, and to define the effects of Reynolds number, surface condition, excrescences, and local and freestream flow conditions on lifting surfaces and complete configuration. Also included will be investigations in support of or verification of wind tunnel studies. Experimental research pertaining to laminar and turbulent boundary layer phenomena and on the separation characteristics of turbulent flow over afterbodies will also be conducted as will analytical studies appropriate to support the fluid mechanics disciplines.

W82-70013 **505-31-51**
Ames Research Center, Moffett Field, Calif.
AERODYNAMIC TEST METHODS AND INSTRUMENTATION
C. Thomas Snyder 415-965-5066

The general objective of this research is to provide the technology for increased ground based aerodynamic experimental research capability required to improve prediction of performance and flight characteristics of conceptual or new aircraft designs and the exploration of advanced aerodynamic concepts. Flow quality, measurement of model attitude and deformation, tunnel wall constraints, and means for simulating higher Reynolds number flows will be investigated analytically and experimentally to improve the quality of test results. Principal focus is to be on the effects of flow quality. To improve the state of the art in nonintrusive measurement capability, advanced laser velocimetric and holographic instrumentation systems will be developed to obtain fundamental fluid mechanic measurements such as mean velocities, turbulence intensities, and Reynolds stress components. Infrared camera technology will be explored as a means of locating shock waves and regions of separation on wind tunnel models.

W82-70014 **505-31-53**
Langley Research Center, Hampton, Va.
EXPERIMENTAL METHODS AND INSTRUMENTATION
R. A. Kilgore 804-827-3711

The technical objective is to provide the technology for increased ground based aerodynamic experimental research capability required to improve our ability to predict the performance and flight characteristics of conceptual or new aircraft designs and to permit the exploration of advanced aerodynamic concepts. In house, contract, and grant research will be used to advance the state of the art with regard to: (1) advanced experimental methods (including cryogenic wind tunnel technology, magnetic suspension and balance systems, and transonic tunnel wall interference); (2) improved instrumentation techniques; and (3) nonintrusive measurement techniques.

W82-70015 **505-31-54**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT TEST TECHNIQUES AND FLIGHT RESEARCH INSTRUMENTATION DEVELOPMENT
E. J. Wilson 805-258-3311

This program will investigate and develop new and improved flight test techniques and research flight test measurement capabilities, which will enable the more accurate and efficient collection of flight test data, and will develop and enhance flight experimental methods, data analysis, and correlation. Flight research instrumentation development is planned and will include an inertially based integrated sensor system, a miniaturized multichannel pressure sensor system, a high accuracy fuel flow meter, and hot wire/film signal conditioning.

W82-70016 **505-31-63**
Langley Research Center, Hampton, Va.
FULL SCALE REYNOLDS NUMBER TEST TECHNOLOGY
L. W. McKinney 804-827-2701

The technical objective is to develop the test technology required to fully exploit the unique capabilities of the new pressurized cryogenic wind tunnels in the performance of research and development studies related to advanced aerodynamic test concepts at full scale Reynolds numbers. This objective will be accomplished utilizing in-house, contract and grant research to: (1) extend development of cryogenic technology and full scale Reynolds number test techniques to insure maximum utilization of the unique research and development capabilities of the new Langley National Transonic Facility. (2) Continue development of technology for sound engineering of models for the high pressure cryogenic environment including establishment of model criteria. (3) Provide instrumentation and measurement techniques capable of operating over a wide temperature range with emphasis on minimizing measurement error and time required for data collection.

W82-70017 **505-31-73**
Langley Research Center, Hampton, Va.
HYPERSONIC AIRCRAFT AERODYNAMICS AND FLIGHT DYNAMICS
F. S. Kirkham 804-827-3877
(505-43-83)

The primary objective of this effort is to provide the fundamental aerodynamic methodology for future hypersonic vehicles through theoretical analysis and experimental investigations of configuration aerodynamics, stability and control, aerodynamic heating, and propulsion system integration. Areas to be emphasized are those which hold the highest potential for future pay offs, such as deriving benefits in vehicle performance from mutual interactions of the vehicle and it's propulsion system. Many aspects of this program such as the advanced analysis techniques are generally applicable to supersonic aircraft and future space transportation systems as well as to hypersonic vehicles. The approach to be used will emphasize the development and application of advanced analytical and experimental methods which are capable of addressing complex flow phenomena such as the propulsion system exhaust. Analysis methods will address inlet spillage, embedded shocks, and new nonlinear aerodynamic analysis and optimization techniques. Experimental methods will include provisions for making force measurments in conventional wind tunnels of models with simulated exhaust flows.

W82-70018 **505-31-83**
Langley Research Center, Hampton, Va.
APPLIED MATHEMATICS
Frank Hohl 804-827-2664

The objective is to provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments. The research is carried out by a combination of in house efforts, university research grants, and the continuing operation of the Institute for Computer Applications in Science and Engineering (ICASE) located at the Langley Research Center.

The in house and grant efforts include research dealing with numerical solutions of differential and algebraic systems, data analysis, computer graphics, symbolic and algebraic manipulation, data base management, programming languages, microprocessor software, and software engineering. The broad research areas pursued in ICASE include: numerical analysis; application of computation techniques; applied computer science; and control theory.

W82-70019 **505-31-91**
Ames Research Center, Moffett Field, Calif.
COMPUTER SIMULATION OF VORTEX WAKES
A. Leonard 415-965-6459
(505-31-11)

The objective is to obtain computer simulations of the vortex wake behind a large airplane. Computer codes will be developed to predict the vortex interaction and dissipation in the trailing wake. The wake flow field will be solved using the Lagrangian discrete vortex approach assuming a time-dependent, three-dimensional incompressible flow. Upstream boundary conditions for the wake flow will depend on the aircraft geometry. The effects of changes in wing configuration, flap deflection, and wing loadings on the vortex wake will be studied in order to identify means for reducing the hazard to other aircraft.

W82-70020 **505-31-93**
Langley Research Center, Hampton, Va.
WAKE VORTEX ALLEVIATION
G. C. Greene 804-827-3611

The objective of this effort is to reduce the hazard potential of wake vortices shed by transport aircraft through aerodynamic techniques without significant detrimental effects on aircraft performance. This objective will be met by developing experimental and numerical analysis techniques to improve the understanding of fundamental flow mechanisms associated with multiple wake vortex generation, their interaction, and decay. In addition, techniques for evaluating the effects of configuration flow-field changes on aircraft response will be developed through simulations using various combinations of generating and following aircraft. These simulations will be used to develop criteria for acceptable vortex encounters.

Propulsion Research and Technology

W82-70021 **505-32-02**
Lewis Research Center, Cleveland, Ohio.
PROPULSION NOISE RESEARCH
C. E. Feiler 216-433-4000

The objective of this research is to provide an understanding of and means for both predicting and reducing propulsion-generated noise at the source with minimum penalties (weight, performance, fuel use, and cost). The research is closely coordinated with other agencies and NASA centers and with industry. The research encompasses both analytical and experimental approaches and is accomplished through inhouse laboratory and scale model studies and by university grants and industry contracts. Where appropriate, acoustic experiments are performed using small engines. Also included in the research are experiments under simulated flight conditions. The noise sources addressed in the work include turbomachinery, high-speed turboprop, core engine, exhaust jet, and shaft engine transmission noise. Duct acoustics is a major element of the research effort. The program consists of three thrusts relative to the foregoing noise sources as follows: (1) fundamental aeroacoustics involving principles of noise generation and propagation; (2) analytical and empirical modeling of the propulsion noise sources and their interactions, including flight effects; and (3) component noise experiments that explore new concepts and/or provide a data base.

W82-70022 **505-32-03**
Langley Research Center, Hampton, Va.
AIRCRAFT ENGINE NOISE RESEARCH
H. G. Morgan 804-827-3577
(505-33-53; 505-35-13; 505-41-43; 505-42-13; 532-06-13; 535-03-13)

The objective of this research is to provide the technology base for understanding, predicting, and reducing or controlling propulsion-generated noise from aircraft systems with minimum weight, performance, and economic penalties. Both analytical and experimental approaches to noise reduction are included and are accomplished in-house and by grant and contract. The experimental portion of the program emphasizes scale model and laboratory studies under closely controlled conditions, supplemented by flight tests where appropriate. The three thrusts of the program are (1) fundamental aeroacoustics which includes basic research on flow-generated noise, jet noise, duct acoustics, and atmospheric propagation; (2) modeling of noise from general aviation, commuter, subsonic and supersonic transport, and helicopter aircraft systems with emphasis on vehicle classes powered by rotating blades; and (3) noise reduction of propulsion system components, especially rotors and propellers, and including the effects of flight on turbofan noise sources.

W82-70023 **505-32-12**
Lewis Research Center, Cleveland, Ohio.
PROPULSION SYSTEM AERODYNAMICS
D. N. Bowditch 216-433-4000
(505-41-52; 505-43-52; 535-03-12; 505-43-22)

Improved analytical and experimental design methodology for inlets, nozzles, and propellers will be generated to achieve higher performance with increased propulsion system stability. Computer analysis programs for predicting internal and external flows will be synthesized in-house and by contracts and grants. These programs will make it possible to analyze viscous and inviscid flows in two and three dimensions. Basic benchmark testing will be done to define detailed flow phenomena to guide and verify the analysis. Verification experiments will be conducted to verify accuracy of computer codes for design of actual components. Inlet, nozzle, and propeller hardware will be designed and used to conduct exploratory research in areas that are not presently amenable to analysis. A counter rotation propeller research program will be pursued, which will include development of analysis and analysis verification by comparison with test results.

W82-70024 **505-32-13**
Langley Research Center, Hampton, Va.
PROPULSION SYSTEM INTEGRATION
W. P. Henderson 804-827-2676

Fundamental studies, both experimental and theoretical, will be conducted to develop an understanding of the flow phenomena associated with the integration of the propulsion system into advanced aircraft concepts. Through this research, propulsion system integration concepts will be studied that are designed to exploit favorable interference effects to reduce drag and enhance wing lift, to incorporate thrust vectoring and reversing to reduce landing and take off distance, and to determine the effects on performance of modifications made to reduce aircraft observables. Experimental and theoretical research will be conducted to improve the understanding of the factors which affect the propulsion system integration for nozzle/afterbodies, nacelle/pylon/wing, turboprop/nacelle/wing, and inlet forebody concepts. Advanced analytical methods capable of predicting the propulsion interaction effects for each of these concepts will be developed. Very detailed experimental data necessary to validate the new methods will be an integral part of this activity. The theoretical methods under development will vary from the simple, faster patched methods to the more complex Navier-Stokes solutions.

W82-70025 **505-32-22**
Lewis Research Center, Cleveland, Ohio.
FAN, COMPRESSOR AND TURBINE RESEARCH
C. L. Ball 216-433-4000

Approaches to improve efficiency, operating range, distortion tolerance, durability, and reliability; and to reduce weight, volume,

and cost of the wide variety of fans and compressors required for advanced propulsion systems will be investigated. The objective of the turbine program is the attainment of increased life and improved performance through improved turbine cooling and aerodynamic design methods for both and axial radial flow turbines. Increasd emphasis is placed on verifying and demonstrating the capability of internal flow analysis codes for improving the accuracy and reliability of compressor and turbine design systems. Accuracy and reliability of design systems and performance prediction methods are improved through more accurate modeling of stage internal flows. The advanced analytical methods will result in large cost savings by reducing both the time required and risk involved in incorporating advanced components into future engine development programs.

W82-70026 **505-32-31**

Ames Research Center, Moffett Field, Calif.

COMPUTATIONAL FLAME RADIATION RESEARCH

R. L. Jaffe 415-965-6458

The objectives of this research are to provide an in depth, theoretical understanding of both combustion processes and spectroscopic techniques used for non-intrusive, laser based flame diagnostic measurements. The research will be coordinated with several experimental programs which are not part of this RTOP. The approach will utilize first principles calculations of the fundamental properties, if they are not well known, of molecules which have important roles in combustion processes. These data will be coupled with the results from numerical flame structure models to produce synthetic spectra which can be compared to experimental flame spectra taken under identical conditions. Significant differences between the experimental and theoretical spectra would indicate deficiencies in the numerical model which would then be improved until agreement is attained. Consequently, this research will lead to the establishment of a validated combustion model which is capable of reliably predicting flame properties. The theoretical molecular property data will also be used to synthesize cross sections for spectroscopic transitions which can be used for diagnostic measurements of flame temperature and composition. This research will help identify new non-intrusive analytical techniques for combustion experiments and add to the effectiveness of existing diagnostic methods.

W82-70027 **505-32-32**

Lewis Research Center, Cleveland, Ohio.

COMBUSTION AND FUELS RESEARCH

L. A. Diehl 216-433-4000

(511-59-12)

The objective of the combustion and fuels research program is to provide technology for advanced combustion and aircraft fuel systems for future civil and military applications aimed at improving performance, durability, and reliability while achieving fuel flexibility and reduced emissions. The effort is focused on (1) developing a fundamental knowledge and understanding of the characteristics and effects of potential alternative fuels, (2) achieving a basic understanding and analytical representation of the fundamental aerodynamic and chemical kinetic phenomena governing the combustion process, (3) developing analytical models for predicting the internal aerothermodynamic performance of combustors and fuel systems, and (4) identifying and evaluating advanced combustor and fuel system concepts. The program includes both fundamental and applied research activities conducted inhouse, under grants to universities and under contracts to industry. Overall coordination with other government agencies, such as DOD, DOE, DOT, EPA, and with industry is maintained in order to provide the proper direction and scope to the program.

W82-70028 **505-32-42**

Lewis Research Center, Cleveland, Ohio.

POWER TRANSFER RESEARCH

L. P. Ludwig 216-433-4000

(506-53-12; 511-58-12)

The objectives of this work are to advance the state-of-the-art in tribological science and in the technology of transmissions and of mechanical components such as bearings, shaft seals, gas path seals, gears, shafts, dampers, lubricants, and lubrication systems. Goals are to achieve improved component performance, life, reliability, and efficiency in the high temperature, high speed, and high pressure environments of turbojet and turbofan engines and mechanical power transmission systems. Emphasis will be given to an interdisciplinary approach to tribological science to create far term opportunities as well as to satisfy goals for both improved component and system performance. Innovative mechanisms and techniques for determining and controlling the dynamic behavior of rotating assemblies (shafts, bearings, dampers, seals, and aerodynamic components) will be created or formulated and corroborated experimentally to enhance the performance of high speed rotating machinery.

W82-70029 **505-32-52**

Lewis Research Center, Cleveland, Ohio.

COMPUTATIONAL FLUID MECHANICS FOR TURBOMACHINERY

W. D. McNally 216-433-4000

(510-55-12)

The objective of the computational fluid mechanics program for turbomachinery is to develop understanding and modeling ability for fundamental internal flow performance, and to develop analytical and computational analyses to simulate and predict the steady and unsteady flow conditions in advanced fans and compressors, cooled turbines, and advanced propellers. The analysis methods are developed into practical codes for use on NASA and industrial computers. Specific objectives are to: originate, develop, and improve analyses for prediction of both steady and unsteady flow effects in advanced fans, compressors, cooled turbines, and propellors; develop new analytical and numerical techniques and models for incorporation into advanced codes; build analysis tools into a practical, highly useful analysis/design system through improvements and integration; incorporate extensive graphics into the analysis codes to maximize understanding of the results; develop methodology to enable the user to more rapidly cover the range of all the parameters in the analysis space; investigate the use of advanced computers for some of the longer running codes; and verify models and codes against experimental data and other solutions.

W82-70030 **505-32-62**

Lewis Research Center, Cleveland, Ohio.

ENGINE DYNAMICS AND CONTROLS RESEARCH

R. G. Willoh 216-433-6624

The objective is to improve the understanding of propulsion system behavior and to provide an improved technology base for future engine system development. Experimental and analytical efforts are undertaken to support the various technical disciplines associated with the dynamic behavior and control of propulsion systems. The approach in the system dynamics areas is to conduct research subprograms on advanced civil and military engines. Particular emphasis is placed on the dynamic interaction problems encountered when the individual components are combined to form an engine system. Subprograms include investigations into system stability, stall recovery, and the effects of various disturbances on system dynamic behavior and performance. Studies will also be made of new component and system technology for improving fuel efficiency, and experimental and analytical research will be conducted to define engine system behavior in the higher frequency ranges (greater than 50 Hz). Control theories and concepts are developed and applied to achieve improved performance, safety, and reliability. Special control hardware, such as servos, sensors, and actuators are developed as required. Dynamic analysis, simulation, and experiments are performed to validate the control theories, concepts, and hardware.

W82-70031 **505-32-73**

Langley Research Center, Hampton, Va.

HYPERSONIC PROPULSION RESEARCH

H. L. Beach, Jr. 804-827-3772

Program is aimed at developing an understanding of the fundamental processes of mixing and combustion in supersonic flows for application to airframe integrated, airbreathing propulsion systems from Mach 3 to Mach 10. Theoretical and experimental studies are conducted in fuel injection, turbulent mixing of fuel

and air, subsonic and supersonic combustion, and 3-D turbulent reacting flows in ducts of complex geometry in order to advance methodology for design and performance prediction techniques. Component investigations are conducted in Langley facilities on inlets, which may be applicable to several types of engines, and combustors and nozzles for modular scramjet engine concepts. Research on subscale, boilerplate engine modules is conducted at conditions simulating flight at Mach 4 and Mach 7 conditions in Langley propulsion facilities. The in house research is augmented in several areas by R&D grants and contracts. This program is focused on providing the basic technology for lightweight, fixed geometry, airframe integrated scramjet engine modules using a dual mode of H2 fuel injection to control mixing and combustion over a wide range of flight speeds. This technology will be applicable to efficient propulsion for either cruise aircraft, accelerating and maneuvering aircraft, airbreathing space launch vehicles, or with hydrocarbon fueled, high speed highly maneuverable missiles.

W82-70032 **505-32-82**
Lewis Research Center, Cleveland, Ohio.
PROPULSION INSTRUMENTATION RESEARCH
N. C. Wenger 216-433-6646

The programs under this RTOP are directed at developing and demonstrating the technology required for significantly advancing the state-of-the-art in propulsion instrumentation. The RTOP focus is on both operational instrumentation for propulsion systems and R&D type instrumentation for fundamental studies and for component and engine development and tests. The activities in these programs include: fundamental studies of basic phenomena that relate to instrumentation; the design, development, and demonstration of prototype sensors and instruments; and the development and automation of large facility type instrument systems. Programs are directed toward developing the following: (1) high temperature transducers and high temperature electronic devices for use in instrumentation systems for future controls, engine monitoring systems, and R&D applications; (2) a wide variety of sensors (surface temperature, heat flux, strain, etc.) for measuring critical propulsion system component parameters, particularly those required for hot section durability studies; (3) a number of laser based coherent optical techniques (laser anemometry, holography, etc.) for measuring detailed flows in a variety of situations that are required for verifying computational fluid mechanics models; (4) and combustion diagnostic instrumentation for fundamental studies of combustion and fuels and for verifying and improving combustion models.

W82-70033 **505-32-90**
Lewis Research Center, Cleveland, Ohio.
ENGINE SYSTEMS FACILITIES OPERATIONS
Joseph A. Yuska 216-433-6898

This RTOP covers the operation, maintenance, repair, and improvements of the Propulsion System Laboratory (PSL), ECRL-2 T-700 Facility, and the Vertical Lift Fan Facility (VLFF) at LeRC. The PSL complex consists of two altitude test chambers, designated as PSL-3 and PSL-4. The ECRL-2 is an indoor sea level test stand for performing research on small turboshaft engines. The VLFF is an outdoor sea level test stand for turbofan and turbojet engines. The objective is to provide propulsion, aerodynamic, and acoustic experimental facilities in support of research and technology programs directed toward improving systems technology for future turbofan, turbojet, and turboshaft engines. This will be accomplished through the application of research subprograms to advanced civil and military engines. Particle emphasis is placed on the stability and dynamic interaction encounted in engine systems. Both altitude chambers will be heavily scheduled. Similar programs are being conducted on a small turboshaft engine in ECRL-2. The VLFF is concentrating on investigation and developing noise suppression techniques for small commercial aviation turbofan engines.

W82-70034 **505-32-92**
Lewis Research Center, Cleveland, Ohio.
WIND TUNNEL OPERATIONS
Arthur J. Gnecco 216-433-5579

This RTOP covers the cost of maintenance, normal repair, and limited improvements of all the wind tunnel facilities at LeRC. These facilities consist of the 10 by 10 foot Supersonic Wind Tunnel, 8 by 6 foot Supersonic Wind Tunnel, 9 by 15 foot Low Speed Wind Tunnel, 6 by 9 Icing Research Tunnel (IRT) and the 1' by 1 foot Supersonic Wind Tunnel. In addition, a number of smaller test stands and test cells performing propulsion research are supported by this RTOP as required.

Materials and Structures Research and Technology

W82-70035 **505-33-12**
Lewis Research Center, Cleveland, Ohio.
METALLIC/CERAMIC MATERIALS
S. J. Grisaffe 216-433-4000

The objective of this RTOP is to provide the technology base for improved materials (alloys, coatings, and ceramics) for use in advanced air breathing propulsion systems, particularly for aeronautical applications. The major efforts in the RTOP are oxidation/hot corrosion, protective coatings, ceramics, and superalloys of low strategic elements. In each effort, materials are sought that offer improvements in technical performance and economy in terms of total life cycle costs. In all elements of the program, basic research is conducted in-house and by university grants. Results of these efforts provide guidance for the more applied work conducted in-house and by industrial contracts.

W82-70036 **505-33-13**
Langley Research Center, Hampton, Va.
HIGH PERFORMANCE STRUCTURAL ALLOYS
R. C. Goetz 804-827-2042
(505-33-23)

The objectives are focused on understanding the metallurgical structure/mechanical property relationships characteristics of advanced structural alloys. This understanding is expected to provide a basis for developing more efficient structural alloys for future aircraft applications. Current research includes: (1) fundamental studies of the structure/property relationships in advanced PM aluminum and titanium alloys as they relate either to alloy chemistry, thermomechanical treatments, or aging behavior; and (2) the development of new/improved processing methods to provide a basis to achieve more efficient structural shapes. Research in advanced PM aluminum alloys will include optimizing powder processing techniques, alloy chemistry, and thermomechanical treatments based on a fundamental understanding of the metallurgical features desirable for high performance applications. Research in processing will emphasize SPF/DB and SPF/WB of titanium, cold forming of Beta titanium, and process adaptability of the advanced PM aluminum alloys.

W82-70037 **505-33-21**
Ames Research Center, Moffett Field, Calif.
FATIGUE DAMAGE AND ENVIRONMENTAL EFFECTS IN METALS AND COMPOSITES
H. G. Nelson 415-965-6137

A combined experimental and analytical program will be performed to characterize and better understand the fatigue and fracture behavior of both metallic and composite (graphite/epoxy) materials used or anticipated to be used in airframe structures. Additionally, an attempt will be made to apply this knowledge, where practical, to help solve existing engineering problems and to apply improved life prediction procedures to real aerospace structures. For composite materials, a modified time-temperature superposition approach is used to establish correspondence between stress, moisture, temperature, and time as these variables influence the durability of complex graphite/epoxy laminates. It is our aim to develop the methodology required to obtain accurate constitutive relationships such that improved accelerated test procedures and life prediction techniques can be applied to real aerospace composite structures, which behave in a viscoelastic manner. Areas of interest include all types of mechanical and

physical behavior including moisture absorption and physical aging. In all cases the ranges of applicability of this mechanics approach are being established though relevant mechanistic investigations. For metallic materials, crack initiation and subcritical crack growth stages of fracture are being characterized using a fracture mechanics approach. Our primary objective is to understand the influences of the chemical environment of fracture behavior in order that we may predict the stress corrosion and corrosion fatigue behavior of aerospace structural materials including advanced powder metallurgy (P/M) aluminum alloys. Considerable emphasis is placed upon understanding the kinetic aspects of embrittlement and in particular the importance of surfaces and surface reactions.

W82-70038 **505-33-22**
Lewis Research Center, Cleveland, Ohio.
LIFE PREDICTION
Marvin H. Hirschberg 216-433-4000
(510-57-12)

The major objective is to obtain a better understanding and description of the creep-fatigue viscoplastic flow and fracture of advanced materials systems. The approach will be to formulate and verify practical concepts involving cumulative damage assessment and life prediction methods that account for interactive effects on the crack initiation, crack propagation and fracture of structural components when subjected to complex time dependent patterns of temperatures and cyclic loads.

W82-70039 **505-33-23**
Langley Research Center, Hampton, Va.
LIFE PREDICTION FOR STRUCTURAL MATERIALS
R. C. Goetz 804-827-2042
(505-33-13; 505-33-33; 506-53-23)

The objectives of this research are to understand the fatigue and fracture behavior of experimental and engineering materials and to develop reliable life prediction techniques that are applicable to the use of these materials in aircraft structures. Formulation of a theoretical framework for life prediction and experimental validation of the theoretical concepts involved form a major part of this research focus. Characterization of the integrity of structural materials by nondestructive techniques is also included. The nondestructive materials research involves both theoretical modeling and experimental verification of advanced ultrasonic/acoustic phenomena as related to understanding fundamental material properties and behavior under complex loads. Research in fatigue and fracture includes structural alloys as well as thick-section, polymeric composites. In depth analyses of the fracture and crack-growth processes will be conducted and comparisons made to validate and extend the reliability of current life prediction models. Nondestructive materials research will focus on providing a scientific basis for quantitative ultrasonic analysis of the integrity and properties of composites and metals. Precision measurement techniques to determine the physical mechanisms of materials behavior such as the mechanics of impact damage in composites will constitute a significant part of the nondestructive materials research.

W82-70040 **505-33-31**
Ames Research Center, Moffett Field, Calif.
COMPOSITE MATERIALS
A. H. Heimbuch 415-965-6274
(505-44-21)

Research and development work will be performed to provide new and modified resins and resin-composite systems for aircraft structures having improved processing and thermo/mechanical properties. Structure-property relationships will be determined, and a data base developed for composite materials. Experimental and theoretical studies will be performed on polymers exhibiting semiconducting properties as a first effort in polymer computational chemistry, and also to develop novel polymers for potential aerospace application. Development work for the predictive test methodology for dynamic and static mechanical properties will be initiated. Phosphorylated bismaleimides, fluorene epoxies, modified polystyrylpyridine, benzyl phenolic and blends of these polymers with flouropolymers and thermoplastics will be investigated as matrix resin systems for composites. A data base will be developed to catalog the chemical and physical properties of resins and their composite systems, and structure-property correlations made. Conducting polymers to be studied include polyacetylene, polyphenylacetylene, poly(paraphenylenesulfide), a chlorovinyl ketone derivative and tetracyanoplatinate structures. Quantum chemistry calculations and computational chemistry will be applied to various macromolecules and their small molecule prototypes. Mechanical properties will be determined for selected samples of candidate composite systems and filed in the data base for correlations and predictive analyses.

W82-70041 **505-33-32**
Lewis Research Center, Cleveland, Ohio.
COMPOSITES FOR PROPULSION COMPONENTS
H. B. Probst 216-433-4000
(505-33-12)

The overall objective of this research is to identify and evolve polymer and metal matrix composite materials and processing technology with potential for aero propulson components having lower weight, higher use temperature and strength, reduced cost, and greater reliability. In the area of polymer matrix composites, emphasis is placed on synthesis of high temperature (to 370 C), processible resins and on development of chemical characterization methodology that supports understanding of polymerization and in-service reactions. In metal matrix composites, emphasis is placed on improving key properties of high temperature composite systems as well as on understanding how these materials fail and degrade so as to overcome their deficiencies. In addition, research on developing the supporting design methodology and fabrication techniques to ready such materials for advanced turbomachinery consideration is also being conducted.

W82-70042 **505-33-33**
Langley Research Center, Hampton, Va.
COMPOSITES
R. C. Goetz 804-827-2042
(505-33-23; 506-53-23)

The objective is to exploit the full weight reduction potential of highly loaded composite structures. The approach is to improve matrix properties, damage tolerant concepts, analytical predictive methods, and understanding of aging effects. Structural resins and adhesives with improved toughness, moisture resistance, processability, and thermal performance will be synthesized. Fundamental factors which control toughness and damage tolerance in resins and composites will be determined. Impact damage and residual strength will be measured and modeled mathematically. The effectiveness of bolted composite joints and woven buffer strips will be studied. Using advanced structural concepts and design methods, flat, curved and stiffened structures will be made and tested in compression, tension, combined loads and after damage. Analytical methods will be developed to predict properties. Long-term durability under expected service environments including the effects of lightning will be studied using ground-based and flight service exposure. Predictive analytical methods for environmental effects will be developed with emphasis on verification of accelerated test methods. Analyses for describing the nonlinear behavior of structures including postbuckling and ultimate strength will be developed. Processing methods for new resin systems will be established with emphasis on economics and consistent quality. Resin rheology and cure mechanics studies will be used as the basis for developing cure processes.

W82-70043 **505-33-52**
Lewis Research Center, Cleveland, Ohio.
LOADS, DYNAMICS AND AEROELASTICITY
G. V. Brown 216-433-6920
(505-33-22; 505-33-62; 505-33-72)

The objective of this program is to develop improved methods of calculating loads, stresses, and deflections in aircraft turbine engines so that the structural design of an engine can be based more on design calculations and less on testing and rebuild procedures. New methods will be developed under this program which can take advantage of increased computer capabilities. The approach will be to develop mathematical models of the

engine. These models will take into account the interactions between components including those at frictional interfaces, and provide a more comprehensive treatment of the internal degrees of freedom of these components. Steady state and transient situations, such as blade loss, will be addressed. The efficacy of special purpose computers with greatly increased speed, and of graphical display methods to facilitate input and output of structures problems, will be evaluated. More thorough methods of predicting aeroelastic stability and forced response will be developed.

W82-70044 **505-33-53**
Langley Research Center, Hampton, Va.
LOADS, AEROELASTICITY AND STRUCTURAL DYNAMICS
R. C. Goetz 804-827-2042
(533-02-73)

The objective is to develop and validate improved methods for analytically determining loads, structural response, and structural stability of aerospace systems considering the dynamic and aeroelastic characteristics of the systems and structural interactions with flight control sub-systems, and to use these methods in the development and evaluation of techniques for eliminating or minimizing flutter, buffet, noise, and other undesirable response phenomena, and for the enhancement of performance, ride quality, crash safety, and service life. Research will be conducted to provide more accurate unsteady aerodynamic theories, particularly in the transonic range. Advanced aeroelastic analysis methods will be evaluated and validated by both wind tunnel tests and flight tests using the DAST concept (Drones for Aerodynamic and Structural Testing). Emphasis will be on measurements of transonic aerodynamic loads, and flight validation of active control systems for load alleviation and flutter suppression. A decoupler-pylon concept for wing store flutter suppression will be evaluated in flight tests on a fighter airplane. Basic wind tunnel flutter studies will be used to gain a better understanding of the flutter characteristics of advanced aerodynamic configurations. Improved methods for the analytical determination of structural response to noise will be developed, and these methods will be used in the development and evaluation of techniques for minimizing noise transmission. Advanced analysis and synthesis capability for predicting and improving transport aircraft crashworthiness and occupant survivability will be developed.

W82-70045 **505-33-62**
Lewis Research Center, Cleveland, Ohio.
INTEGRATED ANALYSIS AND SYNTHESIS
C. C. Chamis 216-433-4000
(505-33-52; 505-33-22; 505-33-32; 505-33-72)

The general objective of this program is to develop accurate and affordable advanced computational methods, computational facility architectures, advanced and generic design concepts, and the methodology and technology needed to support the structural synthesis of engine components and systems in an integrated multi-disciplinary design environment. Generic design concepts and the requisite methodology will be developed for the most promising applications of advanced materials and composites in engine systems. The requisite methodology includes advances in all facets of integrated analysis/synthesis as well as the development of integrated modular computer programs (including software, firmware, and hardware) streamlined for engine systems analysis/design/synthesis. The program is divided among in-house grant and contract efforts distributed as follows: 75% in-house; 15% grants; and 10% contracts.

W82-70046 **505-33-63**
Langley Research Center, Hampton, Va.
DESIGN METHODS
R. C. Goetz 804-827-2042
(506-53-53; 510-54-13)

The objective of this research is to develop integrated multidisciplinary analysis and synthesis methodology for aircraft design with a focus on aeroelastic effects and active controls for flutter suppression, load alleviation, etc., and microprocessors and minicomputer hardware configurations to improve the efficiency of structural analysis. The efforts represent the structures, loads, and aeroelasticity parts of a larger effort called PICASSO (program to integrate controls, aerodynamics, structures, software and optimization) with the ultimate objective of including all significant disciplines simultaneously early in the design synthesis of aircraft.

W82-70047 **505-33-72**
Lewis Research Center, Cleveland, Ohio.
HIGH TEMPERATURE STRUCTURES
R. H. Johns 216-433-4000
(505-33-22; 505-33-52; 505-33-62)

The general objective of this program is to develop the technology necessary for the application of advanced design concepts and materials to aircraft turbine engine structures, and to develop aerothermomechanical structural analysis and design methodology primarily for hot section components of advanced high-bypass commercial engines. Included within the general objective is the development of analytical models and advanced computer graphic modeling techniques necessary for efficient and affordable stress-strain analysis as a function of time and temperature for complex components and load history conditions. Emphasis will be on the development of structural analysis and design methods which will provide reliable, lightweight engine structures having specified durability and life under the extreme environmental conditions experienced in the hot section of an advanced engine. Engine system structural models will be developed to provide analytical capability to account for distortions and displacements due to transient and steady-state thermal and mechanical loads.

W82-70048 **505-33-73**
Langley Research Center, Hampton, Va.
HIGH-TEMPERATURE AERONAUTICAL STRUCTURES
R. C. Goetz 804-827-2042

The objective is to develop engine and airframe structural concepts for high speed aircraft and prepare 8' High Temperature Structures Tunnel for evaluation of flight weight propulsion structure. The approach will be to: complete fabrication of scramjet engine strut for future testing by Langley Hypersonic Propulsion Branch; study initial structural components and fabricate selected engine, fuselage, or wing components for structural test; develop joining techniques for high temperature structural systems; and build prototype O2 enrichment system and inserts to alter Mach number range for 7" Mach-7 pilot tunnel and perform tests to verify practically of these concepts.

Avionics and Flight Control Research and Technology

W82-70049 **505-34-11**
Ames Research Center, Moffett Field, Calif.
NAVIGATION AND GUIDANCE: SHORT RANGE OPERATIONS
D. G. Denery 415-965-5450
(532-01-11; 532-02-11; 532-06-11)

The objective of this research is to develop advanced guidance and control concepts for increasing the safety and efficiency of short range aircraft and helicopters operating in various terminal area environments. The objective will be approached in three tasks. The first is to develop efficient on-board computer algorithms for flying fuel conservative time controlled trajectories in high density airspace. A trajectory management system incorporating such algorithms will be designed and evaluated in flight using a powered lift aircraft and a helicopter as test vehicles. The second task is to develop air traffic control flow management algorithms that exploit the potential of both advanced on-board guidance and ground computers to increase capacity and efficiency. The integration of the airborne and ground algorithms will be evaluated in a controller pilot interactive air traffic control simulation. The third task is to investigate several low cost state estimator concepts for closed loop guidance and control applications.

W82-70050 **505-34-13**
Langley Research Center, Hampton, Va.
NAVIGATION AND GUIDANCE: GENERIC
W. E. Howell 804-827-2132
(534-04-13; 505-34-11)

The objective of this RTOP is to develop technology to apply the advanced concepts required to navigate in the future National Airspace System as proposed by various sources, principally the FAA. The focus for FY-82 will be on the development of theory and techniques to design advanced flight path guidance systems components such as antennas for ground and space communication (e.g., GPS) including their placement on the aircraft and subsequent RF patterns; advanced turbulence detection sensors for safer navigation through adverse weather; and redundancy management techniques for flight guidance and control sensors intended for use with future flight crucial control systems.

W82-70051 **505-34-23**
Langley Research Center, Hampton, Va.
CREW STATION TECHNOLOGY
J. J. Hatfield 804-827-3540
(534-04-13; 504-41-63; 505-34-43; 505-34-13)

Development of advanced crew station technology (such as electronic display generators and media, input/output techniques, and systems integration techniques), coupled with advances in human factors research, can greatly improve the flight deck of advanced jet transport aircraft, cockpits of general aviation aircraft, and crew stations of other types of aircraft. This technology has the potential to reduce clutter and associated workload, and to improve performance, safety, and flexibility while reducing avionics life cycle cost. Work done under this RTOP will develop crew station requirements for future civil missions, identifying candidate concepts for future crew station systems, develop the technology for implementation of these concepts, and perform proof of concept experiments using hot bench, simulator, and flight testing. Technology developments will be focused on: electronic display media such as the CRT, electroluminescent, and liquid crystal panels; on microprocessor display generation, multifunction switching, and touch panel I/O techniques; and on subsystem/system integration techniques. Experimental testing will be performed in the early phases of the program on laboratory and engineering models. Testing will then progress to prototypes and subsystems testing and culminate in the testing, validation, and demonstration of an integrated crew station.

W82-70052 **505-34-31**
Ames Research Center, Moffett Field, Calif.
AIRCRAFT CONTROLS: RELIABILITY ENHANCEMENT
J. A. Franklin 415-965-5009
(505-34-33; 512-54-11; 505-36-11; 505-42-31; 532-06-11)

Advanced control technology will be explored and developed to improve design methodology for precise and reliable flight control systems for advanced aircraft with control redundancy and large flight envelopes that include significant aerodynamic and kinematic nonlinearities. A combination of in-house and contracted studies and University grant research will be used for investigation of nonlinear inverse system concepts and to enhance reliability by: improving and utilizing nonlinear systems theory; developing procedures of least cost and complexity for reconstructing information after sensor failures; establishing the potential of new concepts for redundancy management; and developing microcomputer synthesis concepts and actuation system modeling techniques. University grants will be awarded to support promising research in the field and to keep NASA abreast of new advances in control theory pertinent to analysis and synthesis of reliable flight control systems.

W82-70053 **505-34-32**
Lewis Research Center, Cleveland, Ohio.
PROPULSION CONTROL ELECTRONICS
J. R. Zeller 216-433-6916
(505-32-62; 505-34-43)

The objective is to develop a technology base for designing highly reliable digital electronic controllers needed for future aircraft turbine engine powerplants. Present engines use hydromechanical controllers which exhibit extremely high reliability while operating in a severe environment on the side of the engine. Electronic controllers, needed for the control complexities of future engines, must approach present reliability levels for acceptance into service. The approach will be to employ the latest very-large-scale-integrated (VLSI) circuitry technologies in multiple processor fault tolerant architectures. This approach will need not only hardware developments, but also software technologies for accomplishing a fault tolerant controller. The reliance upon a computer based software control will require studies intended to develop techniques for insuring the integrity and reliability of needed high technology software.

W82-70054 **505-34-33**
Langley Research Center, Hampton, Va.
AIRCRAFT CONTROLS; THEORY AND TECHNIQUES
J. R. Elliott 804-827-4681
(505-41-63; 505-41-73; 505-34-13; 505-34-31; 505-34-34; 505-34-43; 512-54-14; 505-34-23)

The objective of this effort is to develop advanced control system concepts and synthesis techniques which exploit the application of analysis techniques, control devices and integrated design procedures to enhance the performance, safety, and efficiency of future aircraft control system designs. The approach is to conduct studies leading to validation of procedures for mathematical modeling and analysis techniques of flexible aircraft with active controls, to develop and demonstrate computer programs which will provide an optimized control system design, to develop advanced guidance and control system techniques which are practical and consistent with available onboard aircraft instrumentation, to develop aircraft parameter estimation algorithms with improved accuracy and computational efficiency, to develop and validate advanced theoretical concepts for control of aircraft and their trajectories, and to develop an automated system for in-flight monitoring and diagnosis of aircraft subsystem failures.

W82-70055 **505-34-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AIRCRAFT CONTROLS: FLIGHT SYSTEMS CONCEPTS
K. J. Szalai 805-258-3311
(512-54-14; 505-34-31; 505-34-33)

Objectives are to study, develop, and test cost effective methods of implementing and evaluating reliable flight crucial flight control systems that permit greater operational capabilities and increased performance of future aircraft and aerospacecraft. Ground and flight tests will be conducted to verify design methods and validate flying qualities and performance predictions. The emphasis will be on the application of microelectronics, analytic redundancy management, advanced control algorithms, optical communication, and distributed processing to highly reliable fly by wire control systems. In addition, flight test data on shuttle vehicle/system performance and pilot ratings/comments will be evaluated to validate criteria used for the advanced shuttle flight control system. This data will provide a sound basis for modifying criteria for future orbiter vehicles and aircraft employing full authority hybrid fly-by-wire control systems.

W82-70056 **505-34-43**
Langley Research Center, Hampton, Va.
INTEGRATION AND INTERFACING TECHNOLOGY: GENERIC
Billy L. Dove 804-827-3681
(534-02-13; 505-43-73; 512-54-14; 512-54-11)

Aircraft of the 1990 to 2000 period can be more efficient and profitable as a result of new technology advances. The objective of this effort is to accelerate the acceptance of those advances by reducing the risk of the new technology. The approach is to develop the methodology for fully integrating guidance and control functions; identify candidate system architectual concepts; and establish a creditable validation process for advanced digital system designs through the development of new assessment methods, emulation/simulation techniques, and physical testing techniques.

Human Factors Research and Technology

W82-70057 **505-35-13**
Langley Research Center, Hampton, Va.
HUMAN RESPONSE TO NOISE
R. C. Goetz 804-827-2042
(505-32-03; 505-41-43; 505-33-53; 535-03-13)

The objective of this research is to develop technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on aircraft crews and passengers. Research studies will consist primarily of laboratory tests to subjectively evaluate the properties of aircraft generated noise that are responsible for causing annoyance. The laboratory program is aimed at developing criteria for evaluating the noise from single aircraft events as well as evaluating the response to longer term multiple aircraft exposures. Subjects will experience the recorded noise of aircraft or the synthesized noise of future systems under simulated indoor, outdoor, and aircraft interior conditions. Various psychophysical attributes such as annoyance and speech interference will be judged by the subjects. The resulting single event dose-response relationships will be directly applicable to the engineering assessment of source noise modifications and to aircraft certification procedures whereas the multi-event results will be applicable to the evaluation of aircraft/airport operations. Field studies will be directed toward the refinement of a predictive model of community acceptance which includes, in addition to the details of each noise level, the number of events, the time of day/night, and the population distribution. The model will be formulated such that it can be used to assess the noise abatement resulting from A/C modifications, A/C operational changes, and land use strategies.

W82-70058 **505-35-20**
National Aeronautics and Space Administration, Washington, D.C.
SUPPORT FOR THE COMMITTEE ON HUMAN FACTORS OF THE NATIONAL ACADEMY OF SCIENCE
Melvin D. Montemerlo 202-755-3273

This RTOP provides support for NASA's joint sponsorship with the Office of Naval Research (ONR), the Army Research Institute (ARI), the Air Force Office of Scientific Research (AFOSR), of the National Academy of Sciences' (NAS) Assembly of Behavioral and Social Science (ABASS) Committee on Human Factors. The National Academy of Sciences and its committees provide advice to governmental agencies in solving advanced technological problems. The Committee on Human Factors was established to provide advice on determining the most important theoretical and methodological issues in human factors.

W82-70059 **505-35-21**
Ames Research Center, Moffett Field, Calif.
FLIGHT MANAGEMENT SYSTEMS
H. P. Klein 415-965-5094
(505-35-31; 505-35-51; 505-35-61)

This program will investigate flight management and crew/system interaction mechanisms and requirements for current and advanced aircraft. Specific objectives are to develop: (1) guidelines for the design and use of automated systems in the cockpit, (2) new technology for improved current and future man system information interfaces such as navigation charts, operating manuals, warning and status annunciator systems, pilot input systems, and panel displays, and (3) new technology and methodology for aircrew decision aiding. To accomplish these objectives, manned full mission and part task simulations will be conducted to evaluate aircrew performance, workload perception, and decision making in a variety of tasks and mission scenarios. In-house studies, in conjunction with contracts and university grants will be used to develop principles of optimal crew utilization and to evaluate system effectiveness. Collaborative studies with the FAA, industry and the military will be pursued to evaluate subsystems such as alerting and warning systems, cockpit displays of traffic information and crew procedures.

W82-70060 **505-35-23**
Langley Research Center, Hampton, Va.
AIRCREW ROLE IN THE ADVANCED ATC ENVIRONMENT
J. F. Garren 804-827-3621
(534-04-13)

This program will encompass investigations involving pilot workload, system performance, information requirements and display techniques, and pilot/ATC interactions in the context of current fleet aircraft operating in an advanced ATC environment. The scope of this work includes the technical integration of airborne systems with the evolving ATC systems technology, such as datalink applications and cooperative traffic control concepts, coupled with suitable operating procedures to improve safety, efficiency, and capacity. A primary element of the work will be support of the joint NASA/FAA CDTI (Cockpit Display of Traffic Information) Program. Simulation facilities and flight vehicles, equipped with appropriate displays will be operated in conjunction with a simulated ATC environment to represent flight operations in an advanced en-route and terminal area environment.

W82-70061 **505-35-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
HUMAN FACTORS FLIGHT RESEARCH WITH HIGH PERFORMANCE AIRCRAFT AND RPV'S
D. T. Berry 805-258-3311

This program utilizes RPV's (remotely piloted vehicles) and high performance aircraft, particularly those with a single pilot, to develop and evaluate the human factors aspects of highly integrated man/machine systems. The pilot task load will be analyzed during the flights of manned and remotely piloted high performance aircraft. These vehicles will have advanced capabilities such as high authority augmentation systems, direct lift and sideforce, and fuselage pointing. While developing and utilizing RPRV and piloted aircraft flight test techniques the influence of variations in controls and displays on man/vehicle systems will be investigated. Flight programs will be implemented to obtain data on cockpit automation, pilot/crew modeling and flight/simulator validation.

W82-70062 **505-35-31**
Ames Research Center, Moffett Field, Calif.
SIMULATION TECHNOLOGY FOR AERONAUTICS
H. P. Klein 415-965-5094
(505-35-21; 505-42-41)

The general objective of this research and development activity is to provide a scientific and technical base that can be used as a resource to develop valid, reliable, and economical simulators for aeronautical research, development, and crew training. Specific objectives are: (1) to develop human factors principles that can be used to evaluate and guide the effective utilization of flight simulators and automated training devices and (2) to develop advanced hardware and software concepts for high fidelity simulation of vision and motion environments. The first of the two objectives will be met by continuing the study of human factors of reduced visibility scene technology, initiating a study of peripheral cue requirements, refining an analytical method for evaluating simulator motion performance based on human sensory processing model, and studying the potential for improving pilot training through the use of advanced simulation technology and compatible instructional aids. The second objective will be met by developing validation techniques for evaluation of CTOL, STOL, and rotorcraft simulations; developing techniques and concepts for simulation hardware such as computer graphics displays, head-up displays and motion systems; and developing computational techniques that increase the effective speed of digital simulation computers.

W82-70063 **505-35-33**
Langley Research Center, Hampton, Va.
FLIGHT SIMULATION TECHNOLOGY
R. L. Bowles 804-827-3304

This RTOP's objective is the development and application of a technology base that will permit the economical and reliable substitution of simulators for actual flight operations in support of Langley's research programs. It will cover both in-house and contractual studies which address current constraints in Langley

simulator equipment, in the formulation and validation of simulation math models, and in the linkage of hardware/software systems to provide, in the closed loop pilot/simulator environment, effective simulations. Principal tasks for FY-1982 include the conclusion of the correlation effort for man machine model predictions of tracking performance with F-14 in simulator and Dryden flight data, the development and evaluation of improved techniques for wind hazards simulation, a research effort to establish and document flight technical performance for precision approach and landing using state of the art wide angle CGI visual display systems, the development of quantitative pilot assessment techniques, investigations of realizable advances in real time computer technology with application to flight simulation, and the continuation of efforts directed at establishing techniques, methodology, and the analytical basis for large scale mission oriented simulations. Particular emphasis will be placed at LaRC on several technical disciplines, moving within each discipline from a research cell focus for new and emerging technologies to fully integrated system studies and cost/benefit analyses.

W82-70064 **505-35-41**
Ames Research Center, Moffett Field, Calif.
HUMAN FACTORS IN AVIATION SAFETY
H. P. Klein 415-965-5094
(505-35-21; 505-35-31; 505-35-51)

This research is designed to identify factors which contribute to or cause human error in the aviation system, and to exposure methods to prevent human error accidents by eliminating human errors or by minimizing the adverse impact of such errors when they occur. Descriptive studies of the Aviation Safety Reporting System data base will be used to determine system factors associated with human error, and to identify potential solutions to the human error problems so identified. Special studies of the effects of circadian dysrhythmia (jet lag) and fatigue on the performance of pilots and other flightcrew will be conducted to determine the extent to which these factors influence aviation safety, and to determine possible ways to ameliorate these effects.

W82-70065 **505-35-51**
Ames Research Center, Moffett Field, Calif.
WORKLOAD/PERFORMANCE MEASUREMENT TECHNOLOGY
H. P. Klein 415-965-5094
(505-35-21; 505-35-31; 505-35-41)

This program will develop, validate, and standardize objective and subjective measures of pilot workload and performance for current and advanced aircraft. The general objective is to provide guidelines for the use of appropriate measures of performance and workload in a variety of flight related situations to assess the impact of new cockpit displays, systems, procedures, and regulations on aircrews. Specific information will be provided about available techniques, their strengths and weaknesses, validity, reliability, and utility; additional metrics will be developed and tested. To accomplish these objectives, manned part task and full mission simulations will be conducted to validate performance and workload assessment methodologies developed in the laboratory. In-house studies in conjunction with contracts and university grants will develop the candidate methodologies. Collaborative studies with industry and the military will be pursued to maintain relevancy and currency. This program is designed to accept input from other RTOP's and organizations and to provide in turn guidelines, consultation and collaboration in quantifying the impact of hardware, systems, and procedures changes on aircrew and thus on the entire man-machine system.

W82-70066 **505-35-53**
Langley Research Center, Hampton, Va.
CREW WORKLOAD/PERFORMANCE ASSESSMENT
A. J. Meintel 804-827-2489

The research objective is to develop equipment and methodologies for assessing and defining: (1) crew performance, (2) crew workload, (3) display format, and (4) flight crew training enhancement. The approach is to develop the capability of quantifying visual information processes and then apply this capability to understanding how a pilot functions and interacts with this flight environment. This requires participation in the evaluation of current and future flight and ATC systems, development of display and workload evaluation methods, basic visual human factors research, and the development of hardware and software for measuring and analyzing pilot's physiological functions. These efforts are aimed at developing parameters that can be used as quantitative measuring tools for: the development and utilization of crew workload metrics; the evaluation of cockpit displays and development of display design guidelines; and the assessment and enhancement of crew training.

W82-70067 **505-35-60**
Ames Research Center, Moffett Field, Calif.
OPERATION OF THE AERONAUTICAL HUMAN FACTORS FACILITIES, BUILDING N-239/239A
H. P. Klein 415-965-5094
(505-35-21; 505-35-31; 505-35-51)

This RTOP provides for the operation, maintenance, modification, and upgrade of the research facilities of the Man-Vehicle Systems Research Division. The Division conducts a variety of human factors research programs in the areas of flight management systems, human factors in aviation safety, helicopter/VTOL human factors, workload/performance measurement technology and simulation and training technology. The support of the fundamental research activities utilizing the part task and part-system experiment areas, computers and cockpit simulators is the objective of this RTOP. The approach is to provide a complete facility operations staff including computer systems and data analysis programmers, computer operations, computer, and other special purpose electronic and electro-mechanical equipment maintenance technicians, experimental device fabrication technicians, simulation operations engineers, and technicians, and other required facility service such as janitorial support, laboratory rehab and modification, and general building maintenance. Also covered by this RTOP are hardware and software related capital expenditures necessary to upgrade and enhance these laboratories and their component systems.

W82-70068 **505-35-61**
Ames Research Center, Moffett Field, Calif.
OPERATION OF MAN-VEHICLE SYSTEMS RESEARCH FACILITY
H. P. Klein 415-965-5094
(505-35-21; 505-35-31; 505-35-51)

The objective of this RTOP is to provide for the activation, operation, maintenance, modification, and enhancement of the Man Vehicle Systems Research Facility (MVSRF) at Ames. The MVSRF will fill a unique role within the national inventory of aeronautical human factors research facilities. The facility will support human factors research and technology programs for NASA, DOD, FAA, industry and other government agencies in the areas such as: flight management, flight simulation technology, and workload/performance measurement technology. It will consist of a building containing two full mission flight simulators, and ATC simulator, experimenters labs, computer complex, pilot ready area, offices, and shops. The MVSRF is presently in the construction phase and will be fully operational in FY-84. The approach is to engage in a concurrent activation process during FY-82 and FY-83, which will lead to facility readiness, coincident with the project termination phase in FY-84. The activation process consists of providing a competent operations staff; providing the required human factors applications software, including ATC software; procuring the required spare parts and materials; procuring the required test equipment and special tools; providing the required documentation; and planning for successful achievement of the facility research objectives.

Multidisciplinary Research

W82-70069 **505-36-11**
Ames Research Center, Moffett Field, Calif.
FUNDS FOR INDEPENDENT RESEARCH (AERONAUTICS)
M. D. Ardema 415-965-5113
(505-56-11)

The object of this RTOP is to support innovative and discretionary basic research in areas related to aeronautics. The program pursues basic investigations of technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics including the technical fields of aerodynamics, fluid mechanics, flight mechanics, power, guidance and navigation, applied mathematics, propulsion and man machine integration. The OAST Research Council and the Ames Basic Research Council review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and the ABRC to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W82-70070 **505-36-12**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
Marvin E. Goldstein 216-433-4000

The objective is to support innovative, long range, high risk, basic research in areas related to aeronautics. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics. Some of the specific technical fields are fluid mechanics (including turbulence and computational fluid mechanics) propulsion (including fluid mechanics, fans, compressors, fuels, combustors and mechanical components), aeroacoustics, materials, dynamics and control, and aeroelasticity.

W82-70071 **505-36-13**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
Frank Hohl 804-827-2664

The objective of this plan is to support basic research in universities in areas related to aeronautics through the funding of a limited number of unsolicited research proposals. University research proposals that have been evaluated and are not funded through any of the research programs are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be well worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA aeronautics programs.

W82-70072 **505-36-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FUND FOR INDEPENDENT RESEARCH
J. A. Albers 805-258-3311

This RTOP is to support innovative and discretionary basic research in areas related to flight of aeronautical vehicles. The program pursues basic investigation of new technology in fundamental science and engineering needed to improve the performance and efficiency of aeronautical vehicles including the fields of applied mathematics and computer science, materials, structures, aerodynamics and fluid mechanics, propulsion systems, control systems, and flight dynamics. Unsolicited research proposals that have been judged to be worthy of support on scientific or engineering grounds are selected as candidates for funding.

W82-70073 **505-36-20**
National Aeronautics and Space Administration, Washington, D.C.
CFD TRAINING PROGRAM
Randolph Graves, Jr. 202-755-3280

The objective of the program is to produce highly trained people with advanced degrees in computational fluid dynamics (CFD) by developing a balanced graduate training program in CFD at a few selected universities. A balanced program contains training in fluid physics, aerodynamics, computational methods, and computer science.

W82-70074 **505-36-21**
Ames Research Center, Moffett Field, Calif..
AERONAUTICS GRADUATE RESEARCH PROGRAM - FY 1982
C. Thomas Snyder 415-965-5036
(505-36-31)

The objective of this program is to develop the interest of student engineers in the field of aeronautical engineering, provide on the job training in research methods, and augment or enhance NASA's research programs. The approach is to bring the Center's needs to the attention of the academic community. Research topics are established by mutual agreement and the tasks are especially selected to not only be relevant to NASA's mission and of interest to the University faculty, but to foster cooperative programs between the Government and academia. Cooperation may be evidenced by use of others facilities and performance of the research at NASA installations. The research conducted under this RTOP in FY 1982 will include aerodynamics, acoustics, flight mechanics, and computational fluid dynamics. It will be both theoretical and experimental in nature.

W82-70075 **505-36-22**
Lewis Research Center, Cleveland, Ohio.
GRADUATE PROGRAM IN AERONAUTICS
Marvin E. Goldstein 216-433-4000
(505-36-33)

The objective is to sponsor graduate research and training in aeronautics which is relevant and acceptable to both NASA and the university. Starting in FY-1971, grants were awarded, each for a performance period of approximately three years, in areas covering a broad spectrum of research activities relevant to the center's mission in aeronautics. Specific fields of research include fluid mechanics, propulsion, aeroacoustics, materials, dynamics and control, aeroelasticity, and noise emissions.

W82-70076 **505-36-23**
Langley Research Center, Hampton, Va.
GRADUATE PROGRAM IN AERONAUTICS
Frank Hohl 804-827-2664
(505-36-33; 505-36-43)

The objective of this plan is to support university graduate research in aeronautics in which there is a substantial involvement of graduate students at the Langley Research Center. While formal classroom activities are conducted at a university campus, a substantial portion of the graduate research activity is carried out at the Langley Research Center in conjunction with Langley staff and under the overall guidance of a faculty advisor. The research pursued under this RTOP is in areas of aeronautics. Research grants or cooperative agreements are awarded to a number of universities to pursue aeronautical research with support being mainly for graduate research students and to some extent faculty members associated with those students. The selection of graduate research topics is determined by joint agreement between the university and NASA staff.

W82-70077 **505-36-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
GRADUATE PROGRAM IN AERONAUTICS
J. A. Albers 805-258-3311

This RTOP supports university basic and applied research related to improving methods and techniques in flight testing of aeronautical vehicles. The program is to promote the overall improvement in flight research through simultaneous advancement *in instrumentation, testing methods, equipment, data recording,* and data analysis.

W82-70078 **505-36-31**
Ames Research Center, Moffett Field, Calif.
POST-BACCALAUREATE PROGRAM
M. D. Ardema 415-965-5113

The principal objective of this Program is to provide graduate students in aeronautics the opportunity to work with senior NASA engineers in the conduct of advanced aeronautical research. Cooperative research grants will be set up between university professors and NASA researchers for the purpose of bringing

graduate students to the Centers to perform a significant portion of their research.

W82-70079 **505-36-32**
Lewis Research Center, Cleveland, Ohio.
POST-BACCALAUREATE PROGRAM
Marvin E. Goldstein 216-433-4000
(505-36-22)

The objective is to encourage a greater number of newly graduating, U.S. citizen engineers to pursue graduate training in aeronautical engineering. To this end, grants will be awarded, each for a performance period of approximately three years, in areas covering a broad spectrum of research activities relevant to the Center's mission in aeronautics.

W82-70080 **505-36-33**
Langley Research Center, Hampton, Va.
POST-BACCALAUREATE PROGRAM
Frank Hohl 804-827-2664
(505-36-23)

The objective of this plan is to encourage a greater number of newly graduating U.S. citizen engineers to pursue graduate training in engineering areas associated with aeronautics. The RTOP provides support for university graduate research in aeronautics or associated research areas in which there is a substantial involvement of graduate students at the Langley Research Center. While formal classroom activities are conducted at a university campus, a substantial portion of the graduate research activity is carried out at the Langley Research Center in conjunction with Langley staff and under the overall guidance of a faculty advisor. The research pursued under this RTOP is in areas associated with aeronautics. Research grants or cooperative agreements are awarded to a number of universities to pursue research with support being mainly for graduate research students and to some extent faculty members associated with those students. The selection of graduate research topics is determined by joint agreement between the university and NASA staff.

W82-70081 **505-36-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
POST-BACCALAUREATE PROGRAM
J. A. Albers 805-258-3311

This program supports the need to bring newly graduated engineers into our Research Center in order to promote graduate training in engineering. Cooperative research grants between university professors and NASA will bring graduate students to the Center to perform a significant portion of their research. Student research will be directed at supporting basic and applied research related to improving methods and techniques in flight testing of aeronautical vehicles.

W82-70082 **505-36-43**
Langley Research Center, Hampton, Va.
JIAFS BASE SUPPORT
Frank Hohl 804-827-2664
(505-36-23)

The objective of this plan is to provide a core level of funding for the Joint Institute for Advancement of Flight Sciences (JIAFS), which is an extension of the School of Engineering and Applied Science, George Washington University, located at the Langley Research Center. A core program in the JIAFS will be established. This program will have the flexibility for developing new areas of research and further, through support for ongoing administrative personnel and provision for additional Graduate Research Scholar Assistantship appointments, will give JIAFS a degree of institutional stability. The specific research topics in the program will be determined through mutual agreement between LaRC and GWU.

General Aviation Research and Technology

W82-70083 **505-41-33**
Langley Research Center, Hampton, Va.
GENERAL AVIATION MATERIALS AND STRUCTURES
R. C. Goetz 804-827-2042
(505-33-33; 505-42-13; 532-06-13)

A primary objective is to develop technology for composite structures specifically tailored to the requirements of general aviation. Resins, fiber reinforcements, and structural concepts will be developed and evaluated. Manufacturing and processing technology development will emphasize lower material cost and lower tooling and processing equipment costs than current high performance composites such as autoclave cured graphite/epoxy. Specific components will be selected for redesign and low cost manufacturing feasibility will be established. Particular attention will be given to structural durability, impact damage tolerance, and repairability. Another primary objective is to develop methods for improving general aviation aircraft crashworthiness and occupant survivability. Analytical methods for predicting crash impact response of metal aircraft components will be developed. From results of full scale crash tests, important parameters for determining characteristic crash pulses will be defined and the accuracy of advanced nonlinear response prediction methods by correlation with experimental results will be verified. Restraint systems will be provided that will increase potential occupant survibability by 50 percent in crash conditions where the fuselage remains essentially intact. Energy dissipative concepts for general aviation aircraft subfloor structure that significantly improve airframe crashworthiness will be developed and demonstrated.

W82-70084 **505-41-63**
Langley Research Center, Hampton, Va.
GENERAL AVIATION SENSOR AND CONTROL DEVICE DEVELOPMENT
W. H. Bryant 804-827-3404
(505-41-73; 505-34-33; 505-34-13)

The objective of this work is the development and evaluation of advanced display concepts and sensing and control devices that will enhance the safety and utility of general aviation aircraft. The approach is to develop advanced avionics concepts/devices and to evaluate their utility through simulation and flight studies. Both new concepts and those developed for CTOL and VTOL applications will be considered. Examples of research areas include: (1) the use of advanced navigation, control, and display systems to improve path tracking and reduce pilot workload during IFR terminal area operations; and (2) the development of sensor and actuator concepts which provide new measurements or which replace expensive low reliability components. Improved performance and increased capabilities without increased avionics cost are program goals.

W82-70085 **505-41-73**
Langley Research Center, Hampton, Va.
GENERAL AVIATION - SINGLE PILOT IFR SYSTEMS
J. D. Shaughnessy 804-827-3917
(505-41-63)

This effort will provide the background research and develop the technology required to improve the safety and utility of single pilot general aviation (GA) aircraft operating under instrument flight rules (IFR). Functional roles and requirements of the IFR pilot will be determined for current as well as future air traffic systems. The pilot environment, psychological state, workload, required actions, and the interrelationship between these factors will be defined and characterized so pilot effectiveness can be maximized. Aircraft and subsystem requirements will be assessed and design data and guidelines will be developed for systems that significantly aid the single pilot flying under IFR. It will be determined if selected modifications to air traffic control procedures, aids, and pilot training might improve safety and utility of single pilot IFR operations. Analyses, simulation studies, and flight tests will be performed on various cockpit display formats, automatic and manual control systems, advanced avionics

systems, flight data consoles, microprocessor applications, multi-mode displays, flying qualities, procedural and other software concepts, speech synthesis and recognition capability, advanced ATC concepts, and advanced information and flight management systems.

W82-70086 **505-41-83**
Langley Research Center, Hampton, Va.
AERIAL APPLICATIONS AERODYNAMICS AND SYSTEMS INTERACTIONS
R. J. Margason 804-827-3611

The objective of aerial applications research is to improve the effectiveness and efficiency of agricultural production systems through application of aeronautical technology. Specifically, the technology will be developed for both short- and long-term improvements in the accuracy of distribution, environmental, health, and safety aspects of aerial applications and improvements in aircraft aerodynamics, flight controls, structures, and dispersal systems.

Low-Speed Aircraft Research and Technology

W82-70087 **505-42-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT AEROELASTICITY AND STRUCTURAL DYNAMICS
W. H. Deckert 415-965-5043
(505-42-21)

The objective of this research is to improve the predictive capability for rotorcraft loads, vibration, aeroelastic stability, and performance; and where possible to develop rotors with improved dynamic characteristics. This will be accomplished by developing and verifying analytical models for rotorcraft dynamics and aeroelasticity. The accuracy of current and improved models of rotor dynamics will be assessed by comparison with experimental data. As appropriate, small scale and large scale wind tunnel tests will be conducted in order to define dynamics problems and to verify and improve advanced analytical models. Concepts for the reduction of helicopter vibration will be developed. It is important to note that the level of predictive capability required depends on the type of aircraft considered as well as on the technology level. For some simple, well understood rotor systems a satisfactory predictive capability may have already been achieved; for new rotor systems and rotorcraft configurations additional work is required.

W82-70088 **505-42-13**
Langley Research Center, Hampton, Va.
ROTORCRAFT STRUCTURES AND DYNAMICS
R. C. Goetz 804-827-2042
(532-06-13)

The technology for the application of composite materials and design concepts in helicopter structures to improve performance and efficiency, reduce costs, and provide durability and energy absorption capability equivalent of metal structures will be developed through in-house and contractual studies. Long-term durability of Kevlar secondary structures and graphite primary structures will be determined through flight service and structural testing studies. Through anaysis, wind tunnel, and flight studies, effective means for reducing helicopter vibration and evaluating aeroelastic characteristics of new rotor systems will be determined. Active higher harmonic control of vibrations will be developed in wind tunnel studies and demonstrated in flight. Analytical techniques for predicting coupled rotor/fuselage vibration levels will be developed and the application of structural optimization techniques to rotor blade design for minimizing vibrations will be evaluated. Improved predictive methods for analysis of the unsteady airloads on rotors will be developed through in-house and contract studies. Analytical and experimental studies will be made to identify significant factors contributing to the aerodynamic, acoustic, and aeroelastic characteristics of rotors. Methods for predicting and reducing helicopter main and tail rotor noise will be developed and evaluated.

W82-70089 **505-42-23**
Langley Research Center, Hampton, Va.
ROTORCRAFT AERODYNAMICS SCALE MODELING
J. C. Wilson 804-827-3611

The objective is to acquire experimental data, both aerodynamic and acoustic regarding helicopter systems and components for correlation with analyses. Using modeled helicopter systems and the Langley 4-by-7 meter tunnel, experimental investigations will be conducted to acquire rotor performance data for advanced rotor configurations. Rotor noise characteristics will be measured with particular emphasis on blade slap.

W82-70090 **505-42-31**
Ames Research Center, Moffett Field, Calif.
INTEGRATED CONTROL SYSTEMS FOR ROTORCRAFT
D. H. Brocker 415-965-6686
(505-34-31; 512-54-11; 505-42-21; 532-06-11)

Advanced control technology will be developed to provide effective integration of airframe, propulsion, and subsystem control functions to enhance the performance, economic viability and safety of future rotorcraft. Advanced concepts of redundant actuator systems will be studied, and suitable redundancy management techniques developed, with specific attention to system performance, failure effects, reliability and maintainability. Advanced concepts of fault-tolerant data communication will be investigated and a means for integrating the sensing, computation, display and actual elements will be developed. The resulting total fault-tolerant system will be evaluated in terms of safety, cost, reliability and maintainability, using principally manned simulations, and when necessary, flight tests.

W82-70091 **505-42-41**
Ames Research Center, Moffett Field, Calif.
HELICOPTER MAN-SYSTEM INTEGRATION
H. P. Klein 415-965-5094
(532-06-11)

The objectives of this program are: (1) to develop advanced information display, data entry, and pilot interface techniques for industrial, public service and military helicopter operations, (2) to develop pilot workload and stress assessment techniques, and (3) to investigate information requirements, pilot performance limits, and operational procedures for improved helicopter flight operations. Research activities will be continued in FY-82 to develop a helicopter oriented human factors data base concerning a variety of advanced pilot display/control interface techniques, including automatic speech recognition, speech synthesis, and visual auditory, and tactile displays. Research will be continued to develop a methodology for measuring helicopter pilot workload including automated task analysis techniques, simulator measures, pilot models, and flight verification procedures. These activities will be performed in cooperation with work being conducted at Ames by the Army Aeromechanics Laboratory (AVRADCOM).

W82-70092 **505-42-51**
Ames Research Center, Moffett Field, Calif.
HYBRID AIRSHIP TECHNOLOGY
Wallace H. Deckert 415-965-5887
(530-02-11)

The objective of this RTOP is to provide technology development for hybrid airship concepts in the areas of aerodynamics, flight dynamics, structures and materials, and structural dynamics. The main effort at this time will be directed toward making advances in key aspects of the technology where substantial technical uncertainties are known to exist. The emphasis will be shared between development of technology for the short haul, heavy lift concept known as the buoyant quad rotor, and for a concept of interest to the Coast Guard known as the maritime patrol airship. Three specific major objectives are to: (1) investigate experimentally the aerodynamic interference effects between rotors and hull, and to develop analytical models for these effects; (2) investigate alternative control concepts for the heavy lift and maritime patrol airship; and (3) develop structural design criteria for modern hybrid airships.

W82-70093 **505-42-81**
Ames Research Center, Moffett Field, Calif.
LOW SPEED WIND TUNNEL OPERATIONS
W. H. Deckert 415-965-5045

The objective of this RTOP is to support research on basic fluid mechanics, rotorcraft aeromechanics, V/STOL aerodynamics, & the high lift aerodynamics of conventional aircraft. During FY-82, the 40 by 80 foot wind tunnel modification project will be completed. The 40 by 80 foot wind tunnel is scheduled to begin research operations in April 1982 with the 80-by-120 foot test section scheduled approximately six months later. Integrated systems safety reviews, integrated systems tests, flow quality and acoustic calibration, and an operational readiness review will preceed research operations in each test section. The first research programs in the 40 by 80 foot wind tunnel will include the bearingless main rotor and the vertical altitude take off and landing (VATOL) vehicles. The tilt nacelle turbofan (Grumman 698) VTOL model will be the first program in the new 80-by-120 foot test section. The 40-by-80/80-by-120 foot wind tunnel will be scheduled for a combined 1.5 shift per day occupancy. The 7-by-10 foot wind tunnel and the static test facility will be scheduled for a combined one shift per day occupancy. The 7-by-10 foot wind tunnel schedule will include rotary wing fuselage interference, blade fuselage interference and jet in cross flow experimental investigations. The static test facility experimental research programs will include the tilt nacelle VTOL model in ground effect and two dimensional exhaust nozzle research of interest to the Department of Defense.

W82-70094 **505-42-91**
Ames Research Center, Moffett Field, Calif.
LOW SPEED R&T FLIGHT EXPERIMENTS SUPPORT
F. J. Drinkwater 415-965-5687
(532-07-21; 532-02-21; 532-03-21; 532-04-21)

The objective of this effort is to provide ground based support for Ames research aircraft flight experiments in low speed aerodynamics, flight dynamics and control, guidance and navigation and avionics systems. This support activity consists of the operation of ground based facilities for data acquisition and processing, tracking, landing guidance, communications, noise/meteorology, and aircraft instrumentation.

High-Speed Aircraft Research and Technology

W82-70095 **505-43-01**
Ames Research Center, Moffett Field, Calif.
POWERED LIFT RESEARCH AND TECHNOLOGY
C. Thomas Snyder 415-965-6039
(532-02-11)

The objective of this RTOP is to develop basic research and technology required to enable the development of military and civil aircraft having V/STOL and STOL capability and viable mission performance. Theoretical and experimental generic research will be undertaken in the areas of high speed aerodynamics, low speed aerodynamics, and flight dynamics. To insure that all major high speed propulsion system/airframe interactions are accounted for properly, compact propulsion simulator technology will be developed for use in scale wind tunnel models of powered lift configurations. Methods for predicting high speed aerodynamic performance will be refined. Low speed wind tunnel aerodynamic research will concentrate on development of aerodynamic prediction techniques for both transition and ground effects, evaluation of powered lift configurations, improvement of experimental techniques, and evaluation of ejector augmentation. Flight control system and display requirements will be investigated concurrently, primarily through piloted simulation.

W82-70096 **505-43-02**
Lewis Research Center, Cleveland, Ohio:
POWERED LIFT PROPULSION RESEARCH
L. W. Gertsma 216-433-5165

An efficient, lightweight, reliable propulsion system is a critical requirement for the successful design of powered lift aircraft. The technology base for the propulsion system will be developed in selected critical areas which are unique to the powered lift concept. Analytical and experimental investigations will be conducted in the areas of fans, inlets, thrust deflector nozzles, thrust control devices, and control systems operating in the hover and transition modes for both subsonic and supersonic propulsion system concepts.

W82-70097 **505-43-11**
Ames Research Center, Moffett Field, Calif.
FLIGHT VEHICLE DYNAMICS
L. L. Presley 415-965-5851
(505-31-41)

The objective of this research is to provide a basic understanding of the aerodynamic and flight dynamic characteristics of highly maneuverable aircraft through the development and utilization of improved wind tunnel measurement and analytic techniques, including both static and dynamic methods. Ultimately, through application of improved methods of testing and application of the test results, including better simulations resulting from improved aerodynamic mathematical models, new criteria can be established for designing vehicles capable of performing controlled maneuvers over an expanded angle of attack envelope. Investigations are in progress to evaluate various experimental methods for determining dynamic characteristics of aircraft, and experimental capabilities are being upgraded for testing at high angles of attack and high Reynolds numbers, both for static and dynamic characteristics. Dynamic apparatuses are being investigated or constructed to evaluate aerodynamic coefficients which are pertinent to all phases of high-maneuver flight from controlled motions to fully developed spins. A coordinated program of wind tunnel tests and flight tests is planned to provide validation of aerodynamic mathematical models.

W82-70098 **505-43-13**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS
W. P. Gilbert 804-827-2184

The broad objective is to improve the stall/spin characteristics of high performance aircraft, and to determine the effects of these characteristics in terms of piloting the aircraft. Specific objectives are: (1) to investigate the fundamental nature of stall/spin including the development of test techniques and methods for theoretical analysis, (2) to develop and evaluate the effectiveness of automatic spin prevention concepts, (3) to determine static and dynamic aerodynamic characteristics of current and advanced configurations at high angles of attack, and (4) to determine geometric characteristics which result in inherent spin resistance. The methods of approach include static and dynamic wind-tunnel force tests, Theoretical analysis, piloted simulator tests, and dynamic model flight tests. Extensive participation in DOD airplane development programs is involved.

W82-70099 **505-43-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT DYNAMICS AND HANDLING QUALITIES
D. T. Berry 805-258-3311

The overall objective of this effort is to develop improved analytical and experimental techniques related to dynamic and handling quality characteristics of aircraft in all flight regimes. Studies will be conducted to develop analytical techniques for determining stability and control derivatives from flight data, to develop new techniques for evaluating handling qualities, and for achieving desired aircraft responses and to develop improved aeroelastic aircraft analysis techniques. Analytical studies, computer algorithm development and programming, and flight tests will be performed both in-house and under contract and grants to meet these objectives. Improved techniques for estimating the unknown parameters of the math model and for improving the identifiability of the systems will be studied on flight test data. The stochastic control based on the estimates will then be tested in flight to assess the improvement of the system. Also the range of command responses of augmented vehicles that optimizes pilot-vehicle performance for a specific mission or task within a mission will be investigated. Emphasis

will be on criteria for command responses that are meaningful to system designers.

W82-70100 **505-43-22**
Lewis Research Center, Cleveland, Ohio.
AERODYNAMICS AND PROPULSION INTEGRATION
Ross G. Willoh 216-433-6624

The object of the research is to establish through analytical studies, system design efforts, model and full-scale experimental research programs the technology base required for the application of unique configurations to future combat aircraft. The Lewis effort is focused on propulsion system installation. Current activities are specifically directed toward providing the technology required for the design of non-axisymmetric exhaust nozzles for turbine engines. The high maneuverability and STOL requirements anticipated in future aircraft designs lead to the application of non-axisymmetric nozzles capable of thrust vectoring and reversing. Principle areas of concern will include cooling, heat transfer, structural design, weight, and internal aerodynamics. The objectives will be accomplished through contract and in-house studies, nozzle design, and experimental research. Particular emphasis will be placed on solutions to the complex cooling, structural, and internal aerodynamic problems associated with non-axisymmetric nozzles. Close coordination will be maintained with Langley Research Center, the Navy, and the Air Force to assure that work in the propulsion area appropriately supports Air Force requirements and the aerodynamic work at Langley.

W82-70101 **505-43-23**
Langley Research Center, Hampton, Va.
COMBAT VEHICLE AND MISSILE AERODYNAMICS AND FLIGHT DYNAMICS
C. M. Jackson 804-827-3134

The technical objective of this work is to develop the aerodynamic technology base for the design of future military aircraft and missile concepts. Analytical and experimental studies will be made to develop aircraft design rationale and evaluate advanced aerodynamic concepts such as supercritical aerodynamics, wing warp, maneuver devices, thrust induced lift, nonaxisymmetric nozzles, and component interference. Similar studies will be made to extend the aerodynamic technology base for missile systems including conventional cruciform stability and control concepts, airbreathing propulsion integration, and monoplanar concepts. Studies will also be made to provide a technology base for evaluation of missile carriage and separation aerodynamics.

W82-70102 **505-43-32**
Lewis Research Center, Cleveland, Ohio.
INTERAGENCY & INDUSTRIAL ASSISTANCE & TESTING
A. J. Gnecco 216-433-5579

The objective of this RTOP is to support requests from D.O.D., F.A.A., other federal agencies outside NASA and the aircraft/missile industry for aerodynamic testing in facilities at the Lewis Research Center. The facilities typically used under this RTOP include: 10x10 supersonic wind tunnel (SWT), 8x6 SWT, 9x15 WT, icing tunnel, and propulsion system laboratory. Additional support is also provided in the form of technical assistance, consultative services, and participation in the technical evaluation of developing aircraft and missile concepts.

W82-70103 **505-43-33**
Langley Research Center, Hampton, Va.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
R. H. Smith 804-827-4576

The broad objective is to provide technical assistance and consultative services to outside agencies and aircraft industry programs which involve specific requests for NASA support. The principal assistance is to the Department of Defense for aircraft and missile development programs. Currently, activity is focused in the areas of stall/spin; aerodynamic characteristics at subsonic, transonic, and supersonic speeds; flutter and aeroelasticity; structures; landing loads; simulation; and propulsion system interactions on airframes and nozzles. The approach will involve tests in applicable Langley facilities consistent with the availability of test time and the utilization need for the particular facilities requested. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pretest conferences, technical evaluation boards, and technical coordination and oversight committees.

W82-70104 **505-43-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
INTERAGENCY ASSISTANCE AND TESTING
R. G. Bryant 805-258-3311

This RTOP is intended to cover interagency assistance using applicable en flight test facilities. The broad objective is to provide technical assistance, consultative services, and test facility support to DOD for military programs and to industry, which involve specific requests for NASA support. Recent activities of this kind include B-52 drop test for recertification of the F-111 crew escape system; component improvement tests involving F-15, T-37, F-111 aircraft and support of the AFTI-16 (F-16) program. Some current activities include support of the Navy F-18 program and Firebrand research test vehicle program, and the Air Force F-111 crew module recovery system tests. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pre-test conference, technical evaluation boards, and technical coordination committees.

W82-70105 **505-43-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
HIGH SPEED STRUCTURES TECHNOLOGY
Berwin M. Kock 805-258-3311

The objectives are to establish a high temperature structures and materials technology base that permits significant reductions in structural weight by research on new materials, structural design, and fabrication techniques providing satisfactory fatigue, fracture, and thermal/cyclic life characteristics under high speed flight conditions. Laboratory and flight tests will be utilized to: (1) explore the potential of superplastic forming and diffusion bonding of titanium for aircraft applications; (2) evaluate and evolve metal alloys and composite materials and structures for high temperature aircraft requirements; and (3) refine and improve load and structural design techniques and procedures for high-speed aircraft.

W82-70106 **505-43-52**
Lewis Research Center, Cleveland, Ohio.
SUPERSONIC AERODYNAMICS, CONFIGURATIONS AND INTEGRATION TECHNOLOGY
R. E. Coltrin 216-433-6820

Present high speed inlet/engine/airframe integration concepts and methods will be evaluated and the generation of advanced concepts and methods will be initiated. Inlet aerodynamic, stability, and control analysis/design methods will be assembled and evaluated. Existing inlet hardware will be modified and tested to verify aerodynamic and control analysis methods and to provide a data base for areas such as low speed aeroacoustics and high speed off-design and angle-of-attack performance.

W82-70107 **505-43-53**
Langley Research Center, Hampton, Va.
SUPERSONIC AERODYNAMICS, CONFIGURATION AND INTEGRATION TECHNOLOGY
D. J. Maglieri 804-827-3838

The objective of this RTOP is to develop a technology data base for high-speed military and civil aircraft design concepts incorporating improved aerodynamic performance, advanced configurations, and propulsion system/airframe integration techniques. This will be accomplished primarily through in-house studies and experimentation to: (1) establish a supersonic aerodynamic technology base that permits improvement in L/D, reduction in drag, refinement of aircraft concepts, and optimization of aircraft characteristics over the full operating speed range; (2) evolve and refine advanced military and civil aircraft configurations that provide advancements in performance, range, speed, volume, boom signature, fuel consumption, etc; and (3) establish an inlet/engine/nozzle/airframe integration data base and evolve design procedures and methodology for the installation

and control advanced multi-variable systems on high-speed aircraft.

W82-70108 **505-43-61**
Ames Research Center, Moffett Field, Calif.
HIGH-SPEED WIND TUNNEL OPERATIONS
Leroy L. Presley 415-965-5851

This RTOP covers the operation, maintenance, repair, and enhancement of the high speed wind tunnels at ARC. These facilities consist of the unitary plan wind tunnels (11 foot transonic, 9 by 7 foot and 8 by 7 foot supersonic), 12 foot pressure wind tunnel, 2 by 2 foot and 14 foot transonic wnd tunnels, and the 6 by 6 foot supersonic wind tunnel. In addition, a number of smaller scale aerodynamics research and test facilities are maintained and supported as required. The objective of the RTOP is to provide aerodynamic testing in support of research and technology programs for NASA, DOD, industry and other government agencies. Wind tunnel tests will be conducted to generate experimental test data to advance the state of the art in generic research and vehicle configuration research. In addition, facility enhancements and modifications are developed and implemented to meet the testing requirements of the industry and to maximize the energy efficiency and productivity of the facilities. The facilities themselves are maintained on a scheduled basis and repaired as required to maintain the desired level of testing and ensure continued safe operations.

W82-70109 **505-43-64**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AIRCRAFT OPERATIONAL SUPPORT
B. D. Axley 805-258-3311

Equipment, maintenance, and operation are provided for: Support aircraft including F-104N, F-104G, T-38, T-37, C-47, and Bell Helicopter; and service aircraft including B-52, PA-30, and JetStar. Major effort and coordination of activities is provided by inhouse resources with augmentation by supporting contractors (engine maintenance, AGE maintenance, inventory management) and reimbursable military elements (fuel, parts, special functions). This effort supports research flight programs, providing adequate proficiency of pilots, and aircraft, R/D support in terms of research investigations and general operational support.

W82-70110 **505-43-73**
Langley Research Center, Hampton, Va.
INTEGRATED AIRFRAME/PROPULSION CONTROL SYSTEM ARCHITECTURE
Billy L. Dove 804-827-3681
(505-32-62; 505-34-32; 505-34-43)

The objective is to determine the best fully integrated digital airframe/propulsion control system architecture for the next generation high speed aircraft. Advantages offered by advanced technology will be determined and incorporated. The resulting system concept will be designed, developed, and demonstrated. The thrust of this effort will be directed at those high speed aircraft in which integration of airframe and propulsion control functions will be essential to the aircraft concept. A study will be conducted to investigate different system architectures having various degrees of integration and to assess the benefits and disadvantages in terms of cost, maintainability, reliability, etc. Depending on the results of this study, a determination may be made to proceed with the design and fabrication of a ground demonstration system for validation studies in the Langley Avionics Integration Research Laboratory (AIRLAB). Subsequent flight test verification and technology demonstration may occur to achieve the overall objective. The program will be directed by the Langley Research Center with technical assistance by the Lewis Research Center.

W82-70111 **505-43-83**
Langley Research Center, Hampton, Va.
HYPERSONIC AIRBREATHING VEHICLE TECHNOLOGY
F. S. Kirkham 804-827-3877
(505-31-73)

The primary objective of this effort is to conduct applied research and develop key critical technologies to support future development of airbreathing aircraft in the Mach 3 to 6 class. A wide range of specific vehicle types will be technically evaluated to determine the barrier technologies in need of concentrated effort to achieve technical maturity. This will be done through concentrated NASA in-house research supplemented by contracted analysis and design tasks accomplished by industry design teams. A closely coordinated designer/research relationship will be extremely valuable in identifying the high payoff areas in which research should be concentrated. Close communication and coordination of these efforts with appropriate DOD research and development organizations will be maintained to insure a high degree of relevance to future needs. The approach to be used will emphasize the identification and evaluation of promising vehicle concepts by NASA researchers and/or industry designers. These vehicle concepts will be subjected to rigorous evaluations. The opportunities identified will then become the targets of NASA research and development and, given sufficient resources, technology readiness for that particular vehicle class could be achieved.

Transport Aircraft Research and Technology

W82-70112 **505-44-12**
Lewis Research Center, Cleveland, Ohio.
AVIATION METEOROLOGY RESEARCH ICING
R. W. Luidens 216-433-4000

The objective of this program is to update and advance the technology related to the safe operation of aircraft in atmospheric icing conditions. The program addresses the ice protection needs of general aviation, light transports, commercial transports, and helicopters. The program is broadbased, encompassing both analytical and experimental research, and is conducted using in-house, contracted, and university effort. Icing research and development testing will be conducted in the NASA-Lewis icing research tunnel, and in flight tests in natural icing clouds and behind icing cloud simulators. The research will be coordinated among the aircraft industry/users, civilian government agencies, and the military. NASA will serve as the focal point for assembling and disseminating a wide range of data.

W82-70113 **505-44-13**
Langley Research Center, Hampton, Va.
AVIATION METEOROLOGY RESEARCH - STORM HAZARDS
N. L. Crabill 804-827-3274

The objective of this RTOP is to improve the knowledge and understanding of atmospheric processes as they affect the design and safe and efficient operation of aircraft systems. Experimental and analytical programs will be structured to provide data on and new methods for improving the predictability, detection, and avoidance of severe storm hazards, and basic data for the design for those hazards which cannot be avoided. Specific hazards are precipitation (amount and kind), wind and wind shear, turbulence, and in-flight lightning.

W82-70114 **505-44-15**
Jet Propulsion Laboratory, Pasadena, Calif.
CLEAR AIR TURBULENCE STUDIES USING PASSIVE MICROWAVE RADIOMETERS
B. L. Gary 213-354-3198

This RTOP is for flight evaluation of a microwave sensor which is installed in the NASA/Ames C-141 Kuiper Airborne Observatory. The instrument employs passive remote sensing techniques for the determination of an altitude temperature profile for the altitude vicinity of the aircraft (i.e., + or - 3000 ft). The principal use for the sensor is to provide flight level guidance away from altitudes where clear air turbulence (CAT) is being generated. The evaluation will consist of an investigation of the statistical association between the altitude of CAT encounters and the altitude proximity of the tropopause and inversion layers. A second use for the microwave sensor is to provide estimates of the upper limit to the severity of upcoming CAT. These severity limits will be based on measured lapse rates in the layer

generating the CAT. A third use for the sensor is to provide flight level guidance for maximizing tailwinds (and minimizing headwinds) without incurring undesirable fuel consumption penalties associated with changes of air temperature with altitude. This guidance will be based on the statistical association between the altitude of maximum wind and the altitude of the tropopause. Potentially large fuel savings could be achieved from this use. Several hundred hours of data from the sensor will be during the next 2 or 3 years. This should be sufficient for determining if the sensor warrants development for installation on a commercial airliner for pilot evaluation.

W82-70115 **505-44-18**
Wallops Flight Center, Wallops Island, Va.
AVIATION METEOROLOGY RESEARCH ATMOSPHERIC DYNAMICS AND MEASUREMENT TECHNIQUES
R. E. Carr 804-824-3411

The objectives of this RTOP are to collect, analyze and model severe meteorology phenomena such as wind shear, turbulence, heavy rain, lightning and storm dynamics data as they affect the design and safe, efficient operation of aircraft. Meteorological towers, research meteorological radars (SPANDAR), disdrometers, a lightning detection and ranging system and other meteorological support equipment will be used to collect data on meteorological phenomena in severe storms. In addition, ground truth data support will be provided to instrumented aircraft which penetrate such storms. Radar measurements of rain rates will be collected for comparison with theoretical models. A computer model of the effects of heavy rain will be used to support wind tunnel testing of such effects.

W82-70116 **505-44-19**
Marshall Space Flight Center, Huntsville, Ala.
AVIATION METEOROLOGY RESEARCH
Dennis W. Camp 205-453-2087

The objectives of this RTOP are: (1) to define, investigate, and model those atmospheric conditions having adverse effects on aircraft operations from an efficiency and safety standpoint; (2) to conduct research relative to the development of techniques and procedures for enhancing the safe and efficient operation of aeronautical systems; and (3) to develop and/or improve meteorological instrumentation and methods as needed to acquire the necessary data to accomplish the first two objectives. The approach will be to continue to: (1) measure and analyze atmospheric data; (2) develop models of atmospheric boundary layer properties and the conditions which lead to or intensify them; (3) perform analytical and field tests relative to investigating the dispersal of warm fog; and (4) develop and/or modify instrumentation as needed to meet the requirements of this approach. In order to accomplish the objectives, the following tasks will be performed: Task 1: correlation of lateral and longitudinal gusts and their effects on aeronautical systems, and conduction of the annual aviation meteorology workshop; Task 2: atmospheric dynamic process definition as related to aeronautical system operations; Task 3: warm fog investigative studies relative to its dispersal; Task 4: investigation into the use and development of new or improved methods and/or instrumentation to enhance safety and efficiency of aeronautical systems; and Task 5: atmospheric electricity as related to safe operation of aeronautical systems.

W82-70117 **505-44-21**
Ames Research Center, Moffett Field, Calif.
AVIATION SAFETY TECHNOLOGY - OPERATIONAL PROBLEMS AND FIREWORTHINESS
C. T. Snyder 415-965-6219
(505-33-31; 534-05-11)

One objective of this RTOP is to improve aviation safety by increasing the understanding of the causes of accidents; and by developing systems technology and piloting techniques for avoiding hazards. Research on post accident analysis techniques is a cooperative program with the national transportation safety board, bureau of aviation safety (NTSB-BAS). Simulation and flight investigations will be conducted on the effectiveness of integrated head up displays (HUD) on reducing hazards associated with wind shear and low visibility. Research will also be conducted to enhance the operational safety of IFR operations for civil and military rotorcraft and V/STOL aircraft. A second objective of this RTOP is to improve aircraft cabin safety in post crash fires. The program includes: (1) development of a cost beneficial survivability model for aircraft fire safety; (2) development of light weight graphite composites for aircraft interiors; (3) fuel antimisting studies and the determination of fluid properties of modified jet fuel for inhibiting the ignition of fuel; (4) evaluation of fire resistant decorative films for aircraft interiors; (5) development of fire test methodology such as combustion toxicology, heat release studies and flame spread; and (6) development and evaluation of advanced aircraft materials for testing by the FAA.

W82-70118 **505-44-23**
Langley Research Center, Hampton, Va.
AVIATION SAFETY TECHNOLOGY
R. E. Bower 804-827-3285
(505-44-13)

A data base of aircraft operating environments for use in updating manufacturer's design criteria using onboard flight recorders will be compiled. Effective radar techniques will be determined for thunderstorm turbulence and wind shear detection with flight tests of an experimental Doppler weather radar. Comparisons will be made with penetration aircraft winds and turbulence and with ground based Doppler weather radar. Spanwise gradients of atmospheric turbulence in terminal area operations will be measured. A large rigid wing aircraft will be instrumented at both wing tips and the nose to measure atmospheric turbulence in low altitude holding, approach, and landing. Support will be provided for research aircraft engaged in demonstration of methods of flying efficient flight paths in terminal area operations.

W82-70119 **505-44-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
TRANSPORT AIRCRAFT REMOTELY PILOTED GROUND IMPACT TEST (TARGIT)
M. R. Barber 805-258-3311

The objective of this RTOP is to demonstrate and extend the state of the art of transport aircraft crashworthiness. Actual crash of a remotely controlled Boeing 720 aircraft will be used to: (1) demonstrate improved aircraft crash survivability resulting from the use of antimisting kerosene as a flame retarding fuel, and (2) evaluate the effectiveness of recent technological developments in passenger cabin crashworthiness concepts. This test is a joint FAA/NASA effort wherein the FAA has led the flame retardant fuel research and NASA has led the cabin crashworthiness research.

W82-70120 **505-44-25**
Jet Propulsion Laboratory, Pasadena, Calif.
AVIATION SAFETY TECHNOLOGY - APPLIED FLUID MECHANICS
Paul F. Massier 213-354-3549

The overall objective of this effort is directed toward improving aircraft fire safety. The studies include those aspects of safety associated with: (1) experimental investigations to study the ignition and flame spread characteristics of aircraft ceiling panels under superimposed radiation, and to study detailed modeling assumptions and methodologies; (2) the development of a detailed fire modeling methodology for the prediction of aircraft fire characteristics; and (3) thermochemical modeling.

W82-70121 **505-44-27**
Lyndon B. Johnson Space Center, Houston, Tex.
AIRCRAFT FIRE SAFETY AND TESTING
D. E. Supkis 713-483-3211

This RTOP consists of work originally started in FY 75 and continued through FY 81. The RTOP provides for developing and testing fire retardant nonmetallic materials, continuing development and characterization of polyimide end items, developing secondary aircraft structures, and the fabrication of modules for in-house testing, testing by the aircraft industry and by associated agencies.

W82-70122 **505-44-32**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT SYSTEMS OPERATING EFFICIENCY IMPROVEMENT
Donald L. Nored 216-433-4000

Preliminary results from phase one indicate that if the detail implicit in high resolution windfield and temperature data can be retained, fuel savings of between 2 and 3 percent are possible. The objective of phase two will be to evaluate those technologies which offer the most promise in translating this potential fuel savings to operational status to meet the needs of the United States aviation industry. To achieve this objective, the use of man computer interactive video techniques will be applied to the development of a high resolution wind and temperature data base at cruise altitudes. This data base, consisting of satellite, aircraft, radiosonde, and numerical weather prediction model data, when optimized through human/computer interactive methods, will be evaluated against the present operational data base as well as against actual data.

W82-70123 **505-44-33**
Langley Research Center, Hampton, Va.
AIRCRAFT SYSTEMS OPERATING EFFICIENCY IMPROVEMENT
R. C. Goetz 804-827-2042

The specific objective is to examine new concepts and techniques which can reduce both operational complexities and costs of aircraft landing systems. Aircraft operations on prepared runways under adverse weather conditions and on certain unprepared surfaces present requirements of braking and steering systems, tires, and the runway that are vital to aircraft safety and passenger comfort. Objectives of this program are: (1) improve performance of braking systems; (2) improve the wet traction and lifetime of pneumatic tires; (3) develop new landing gear systems that would permit operations on unprepared fields, including water, and permit continuous use of prime runways for all weather operations; (4) evaluate tire cornering behavior with and without braking such that high speed turnoffs can be designed to increase the flow of traffic at congested airports; and (5) relate the character of the runway surface to aircraft braking and steering performance. In FY-82, analytical tire models will be completed with modeling efforts supported by ground tests to define heat buildup and temperature distribution in the carcass. Studies of an active control system to alleviate loads encountered in landings on damaged runways will be continued. Braking and steering concepts for air cushion landing systems on both land and water will be investigated. Brake dynamic characteristics of conventional aircraft will be incorporated into antiskid simulations. Studies of effects of blown tires and failed wheels on aircraft runway performance will be initiated.

Aeronautics Systems Technology Programs

Materials and Structures Systems Technology

W82-70124 **510-54-13**
Langley Research Center, Hampton, Va.
INTEGRATED PROGRAMS FOR AEROSPACE-VEHICLE DESIGN (IPAD)
R. C. Goetz 804-827-2042
(505-33-63)

The objective is to reduce vehicle design cycle time and design costs in the 1980's through development of components of a computer software system denoted IPAD for the total management of aerospace vehicle design processes. System design and prototype software will demonstrate a 25 percent reduction in flow time for vehicle preliminary design tasks, a 50 percent reduction in man hours to assemble engineering data for component design, and a 25 percent reduction in time and cost to generate engineering drawing data. The Industry Technical Advisory Board (ITAB) will review and critique development work and will be provided software components for evaluation and use as they are developed. Continued coordination will be maintained with the Air Force Integrated Computer Aided Manufacturing (ICAM) program to maximize benefits from the two programs. Major emphasis in FY-82 is on improving performance of engineering data management software under development, redesign of this software in preparation for implementation on a second host computer and understanding joint USAF/NASA data management requirements for computer aided design and computer aided manufacturing.

W82-70125 **510-55-12**
Lewis Research Center, Cleveland, Ohio.
AEROELASTICITY OF TURBINE ENGINES
C. L. Ball 216-433-4000
(505-32-22; 505-32-52; 505-33-52)

The aeroelastic program is directed toward improving flutter boundary design criteria so that the occurrence of flutter in fans and compressors for advanced propulsion systems is essentially avoided. If flutter is encountered these criteria may also be used to expeditiously clear flutter from the operating region. The program will also provide, through analytical and experimental research, a more fundamental basis for reliable analysis, prediction and thus the avoidance of instability regions. Analytical methods and computer codes will be developed to predict the unsteady aerodynamic forces under various flutter conditions, and to calculate the structural modes of blades, shrouds, and disks as utilized in fans and compressors for advanced engines. The unsteady aerodynamic analysis will be verified in cascades in which the blades are driven as if they are in flutter. The structural analysis will be verified in a vacuum spin rig and in vibration rigs. The coupling of the aerodynamic forces and structure will be verified in suitable instrumented experimental fans. The prediction method will be further verified by application to realistic data such as that obtained in full scale engine research programs. This aeroelastic program is the NASA portion of an interdependent and coordinated program involving LeRC and AFAPL. The effort involves inhouse projects, as well as contract research with aerospace companies, and grants to various universities.

W82-70126 **510-57-12**
Lewis Research Center, Cleveland, Ohio.
TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST)
Daniel J. Gauntner 216-433-4000

The HOST program will develop the analytical tools needed for improving the prediction of the durability of combustor liners and turbine vanes and blades of advanced aircraft turbines. HOST will consist of contracted and in house research efforts of both an analytical and an experimental naturel in several technical areas. The analytical aspects will include computerized models and predictive tools to describe the service environments and complex loading conditions of these engine components. The experimental aspects will provide new input data to the analytical models and will enable demonstration of the validity of the models and their superiority over present methods.

Propulsion Systems Technology

W82-70127 **511-58-12**
Lewis Research Center, Cleveland, Ohio.
HELICOPTER TRANSMISSION TECHNOLOGY
E. V. Zaretsky 216-433-4000
(505-32-42)

The goals are to develop the technology for design, and test advanced transmission systems for helicopter applications, and to extend bearing, gearing, lubrication, and traction concepts to achieve lightweight, compact, low noise, long life, low cost, mechanical power transmission systems for advanced commercial and military helicopters. The specific program objectives are to: (1) demonstrate a helicopter hybrid traction drive which is more

compact and more reliable while being less costly and quieter than conventional transmission systems (the hybrid drive is expected to have comparable or slightly better efficiency than current helicopter drive systems); and (2) demonstrate on standard type transmission systems advanced NASA bearing, gearing, seals, and lubrication technology whereby transmission life is increased by 200 percent, load carrying capacity is increased by 50 percent, and survivability is increased by 400 percent.

W82-70128 **511-59-12**
Lewis Research Center, Cleveland, Ohio.
BROAD SPECIFICATION FUELS TECHNOLOGY
L. A. Diehl 216-433-4000
(505-32-32)

The objectives of this effort are to evolve the combustion system technology required to use fuels with moderate ranges of broadened properties in commercial jet aircraft with advanced high pressure ratio, high bypass ratio, turbofan engines. These objectives must be achieved while current engine performance and durability levels are maintained, and while appropriate emissions requirements are met. The effort is being conducted through parallel multi-phase contracts with Pratt & Whitney Aircraft and the General Electric Company. These multi-phase contracts will consist of two consecutive phases which will systematically screen out the most promising combustor concepts for using broad properties fuels (phase I), and evolve these concepts into component hardware which is compatible with an existing engine (phase II).

Avionics and Flight Controls Systems Technology

W82-70129 **512-54-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED GUIDANCE AND CONTROL SYSTEMS: VALIDATION TECHNOLOGY
D. G. Denery 415-965-5048
(532-06-11; 505-34-43)

The objectives of this Joint NASA/FAA Program are to: (1) assure a rapid, effective dissemination to the FAA of verification technology advancements and program results which could be used to establish or refine certification criteria and (2) develop, enhance, and analyze advanced verification techniques applicable to digital flight control systems (DFCS). The approach involves the use of a representative near-term DFCS facility to develop, adapt, evaluate, and improve promising state of the art verification and validation tools and techniques. Automatic software verification tools plus hardware verification and system validation tools/techniques are included. A series of workshops and hands-on sessions will be organized to keep the FAA abreast of this technology and to summarize the results of each major program element to industry and Government.

W82-70130 **512-54-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED GUIDANCE AND CONTROLS: FLIGHT SYSTEMS EXPERIMENTATION
C. R. Jarvis 805-258-3311
(505-34-34; 505-34-31; 505-34-32; 505-34-33; 505-34-43)

The overall objective of this effort is to provide the technology necessary for the implementation of advanced, reliable flight control systems in future aircraft for improved performance and efficiency. A highly modified research aircraft (F-8) and associated Iron-Bird are being used as a unique 'laboratory' in support of these controls research and development activities exploiting state-of-the-art advancements in microelectronics technology. A joint program with the British RAE is underway to develop and evaluate advanced flight control laws for improved flying qualities. Techniques are being evaluated to eliminate the necessity of back-up controls required by current fly-by-wire systems to circumvent generic software failure problems and innovative control system architectures are being investigated.

Aeronautical Systems Studies

W82-70131 **530-01-13**
Langley Research Center, Hampton, Va.
GENERAL AVIATION SYSTEMS STUDIES
L. J. Williams 804-827-3838

The objective of this research is to identify promising advanced technologies, the barriers restraining the application of these technologies, and the research and technology efforts necessary to bring these technologies to the point of application by the general aviation and commuter manufacturers and operators. In order to accomplish this objective, studies will be conducted of potential future general aviation and commuter aircraft designs to evaluate candidate advanced technologies in terms of improvements in performance, efficiency, productivity, economics, safety, and passenger acceptance. Studies will also be conducted to identify the aircraft design mission goals that would offer the greatest improvement in the U.S. air transportaion system.

Low-Speed Systems Technology

W82-70132 **532-02-11**
Ames Research Center, Moffett Field, Calif.
PROPULSIVE-LIFT TECHNOLOGY RESEARCH
John A. Cochrane 415-965-5662

Advanced propulsive-lift technology has been shown to provide significant improvements to civil and military aircraft operating in CTOL, RTOL, and STOL modes. Exploitation of these benefits requires research into parameters affecting performance, flight control systems, stability augmentations, cockpit displays, and operating procedures. In addition, operation of aircraft incorporating this technology in either a civil or a military environment requires the development of civil certification criteria, military specifications, and design data for use by procuring agencies, regulatory agencies, and the aerospace industry. The quiet propulsive-lift technology research program addresses these problems with a multi-discipline flight program using the quiet short-haul research aircraft (QSRA) equipped with a highly capable digital computer and advanced electronics displays and a programmable head up display. The flight program is supported with a comprehensive simulation and analysis program. A high speed wind tunnel program will provide for an investigation of cruise drag and means for minimizing it. The program will investigate aerodynamic performance including the application of propulsive-lift techniques to CTOL type aircraft to either reduce field length or increase payload at equal field length. Maneuvering enhancement through the application of propulsive-lift will be investigated for civil noise abatement, fuel conservation, and military applications. Simulation and analytical support will be provided to the U.S. Navy for the NAVTOLAND Program.

W82-70133 **532-02-21**
Ames Research Center, Moffett Field, Calif.
QSRA FLIGHT EXPERIMENTS SUPPORT
F. J. Drinkwater 415-965-5687
(532-02-11; 532-07-21)

This RTOP provides for flight vehicle operational and maintenance support for the flight test program using the quiet short-haul research aircraft (QSRA). The flight experiments will furnish the U.S. Government and aircraft industry with flight data to develop design and certification criteria for military and civil aircraft utilizing propulsive lift for performance improvement. The QSRA will be utilized as a national propulsive-lift flight facility.

W82-70134 **532-03-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED ROTOR SYSTEMS TECHNOLOGY/RSRA OPERATIONS
Wallace H. Deckert 415-965-6570
(532-03-21; 532-06-11; 505-42-21; 530-02-11)

The objective of this systems technology program is to provide and validate integrated rotor system technology required to substantially improve the performance, utility, efficiency, dynamics, noise, maintainability and ownership cost of civil and military helicopters through system design studies, focused small-and large-scale tests in groundbased facilities, and selected flight tests of current state-of-the-art rotors and advanced concept rotor systems. The goals of this program are to: (1) advance the aerodynamics and structural dynamics technology of rotor blades to increase performance and efficiency, and to reduce noise, vibration, weight, cost, and control system requirements; (2) improve rotorcraft gust response and flight stability and control characteristics through utilization of active rotor control and composite construction technologies; (3) expand the ground-based facility data base on rotors of opportunity, on a family of new blades having systematic variations in aerodynamic design parameters; and (4) expand the flight data base on existing rotors that can be readily adapted for evaluation on RSRA (and other test rotorcraft).

W82-70135 **532-03-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT TEST OF ROTOR SYSTEMS RESEARCH AIRCRAFT
W. D. Painter 805-258-3311

This RTOP covers Dryden Flight Research Center (DFRC) planning and support with Ames Research Center (ARC) for the flight test of the rotor systems research aircraft (RSRA) program. DFRC will support a joint flight test team needed to successfully complete the flight test program. This plan covers the conduct of the fixed wing flight testing of the RSRA at DFRC considering the overall technical objective, manpower, funding, and program schedule.

W82-70136 **532-03-21**
Ames Research Center, Moffett Field, Calif.
RSRA FLIGHT EXPERIMENTS SUPPORT
F. J. Drinkwater 415-965-5687
(532-03-11; 532-07-21)

This RTOP provides for flight vehicle operational and maintenance support for flight test programs using two rotor systems research aircraft (RSRA). The aircraft support a program to develop and validate integrated rotor system technology to substantially improve the performance, utility, efficiency, dynamics, noise, maintainability, and ownership cost of civil and military helicopters. More specifically, RSRA are used for selected flight tests of current state-of-the-art rotors and advanced concept rotor systems.

W82-70137 **532-04-11**
Ames Research Center, Moffett Field, Calif.
TILT ROTOR RESEARCH AIRCRAFT FLIGHT INVESTIGATIONS
W. H. Deckert 415-965-5020

Two XV-15 Tilt Rotor Research Aircraft were developed in a completed joint NASA/Army Experimental program that was initiated to advance the technology of the tilt rotor V/STOL aircraft. The significant ongoing effort is the flight investigations phase of a joint NASA/Army/Navy XV-15 Tilt Rotor Research Aircraft (TRRA) Project. Aircraft development was completed in 1979, and the proof of concept flight tests to be completed in 1981 will satisfy the basic objectives of the project, namely verify rotor/pylon/wing dynamic stability and performance, establish a safe operating envelope, qualitatively assess handling qualities, investigate gust sensitivity, and investigate the effect of disc loading and tip speed on downwash and noise in the hover mode. Most of this work has already been completed including high risk proof of concept testing at Dryden Flight Research Center. Other goals of the ongoing Flight Investigations Program are to provide the U. S. aircraft community the design criteria and operational data required for military or civilian development of tilt rotor aircraft to proceed with low technical risk and to provide certification criteria for tilt rotor V/STOL aircraft. These goals will be accomplished by conducting flight tests using civilian and military mission profiles and concurrently proceeding with a detailed performance and handling qualities evaluation of the aircraft that will be carefully documented. High priority will be given to terminal area operations to provide the data base for the final phase of flight testing that will include guidance and control experiments. Studies will be conducted in areas where new technology holds promise for significant payoff when applied to tilt rotor aircraft.

W82-70138 **532-04-21**
Ames Research Center, Moffett Field, Calif.
TRRA FLIGHT EXPERIMENTS SUPPORT
F. J. Drinkwater 415-965-5687
(532-04-11; 532-07-21)

This RTOP provides operational support for flight test programs using the two Tilt Rotor Research Aircraft (TRRA). The goal of this flight program is to provide the U.S. aircraft community with the design criteria and operational data required for development, certification, and operation of tilt rotor V/STOL aircraft with low technical risk.

W82-70139 **532-06-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED ROTORCRAFT PROPULSION TECHNOLOGY
Nick E. Samanich 216-433-4000
(505-42-21; 505-42-31; 530-02-11; 505-44-12; 511-58-12)

Part of the NASA Rotorcraft Program is aimed at advancing technology in engine components, transmissions, and propulsion system integration. Objectives are to improve propulsion system durability, relability, and cruise fuel consumption, to reduce life cycle costs, to develop propulsion technology unique to high productivity vehicles, and to increase operational capability and flexibility. Because of FY-82 funding cutbacks, it has become necessary to transfer all generic small engine component efforts to the research and technology division of OAST. Component work under this RTOP will now be limited to: (a) that required for continuity during the transition and (b) components having unique rotorcraft related problems. The program includes development of an advanced fabrication technique for cooled radial turbines and a continuing technology effort in controls, icing, and diagnostics. Transmission work involves developing and experimentally verifying design methods for large advanced transmissions. Systems efforts include evaluation of advanced engine concepts including convertible engines for high speed rotorcraft, emergency power, and part power performance enhancement techniques. Technology readiness will be demonstrated in an experimental propulsion system incorporating advanced engine and power transfer components and concepts.

W82-70140 **532-06-13**
Langley Research Center, Hampton, Va.
ADVANCED ROTORCRAFT TECHNOLOGY
R. C. Goetz 804-827-2042
(505-42-13; 505-32-03)

The objectives of this research are to develop advanced composites technology for low risk primary helicopter airframe designs that provide increased vehicle efficiency and productivity through reduced fuel consumption and life cycle costs along with increased payload and mission capability, to develop the technology for reducing the interior noise of helicopters through transmission/mainframe isolation, to develop the technology for improving rotor noise prediction methodology through the acquisition of model scale performance, pressure loading, and acoustic data, and to verify analysis models for use in prediction of airframe vibrations. The composite effort will focus on aggressive design and fabrication concepts beyond the current state of the art technology. Contract studies will be performed of rotorcraft interior noise with emphasis on quantifying the noise radiated by the transmission and attenuating this noise by means of isolator systems. In the noise prediction area, model scale performance, pressure loading, and acoustic data will be acquired in the Langley 4 x 7m tunnel for the purpose of developing and validating first principles noise prediction methods, to guide a Langley/Ames cooperative flight experiment using the RSRA, and to validate wind tunnel technology for use in determining the performance and noise characteristics of new rotorcraft. Shake tests of a full scale helicopter will be performed to provide data for a correlation of a finite-element model of the airframe.

W82-70141 **532-07-11**
Ames Research Center, Moffett Field, Calif.
SIMULATION FACILITIES OPERATIONS
C. Thomas Snyder 415-965-5162

This RTOP covers support and operations of the flight simulation facilities at Ames Research Center. These facilities consist of the flight simulator for advanced aircraft, the vertical motion simulator, and a flight and guidance laboratory. The objective of this RTOP is to provide flight simulation support in research and technology programs for NASA, DOD, FAA, industry, and other government agencies in the areas of handling qualities, flight dynamics, control systems, guidance and navigation, and cockpit displays. Flight simulation experiments will be related to various types of aircraft and rotorcraft, as well as space shuttle vehicles.

W82-70142 **532-07-21**
Ames Research Center, Moffett Field, Calif.
FLIGHT EXPERIMENTS SUPPORT
F. J. Drinkwater 415-965-5687
(505-42-91; 532-02-21; 532-03-21; 532-04-21)

The objective of this effort is to provide an overall support activity for Ames research aircraft flight experiments in low speed aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems. This overall support activity consists of aircraft operations and maintenance required to carry out the flight tests, and the operation of ground based facilities which provide data acquisition and processing, aircraft tracking, landing guidance, communications, noise and meteorological measurements, and aircraft instrumentation.

High-Speed Systems Technology

W82-70143 **533-02-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FLIGHT EXPERIMENTS ADVANCED FIGHTER TECHNOLOGY INTEGRATION/F-111 (AFTI/F-111)
L. J. Caw 805-258-3311

The objective of this program is to conduct a series of flight experiments. Dryden Flight Research Center will operate an F-111 aircraft and conduct an investigation of the mission adaptive wing (MAW) as a part of NASA Air Force AFTI-111 Program. Dryden will participate in design review, develop and operate instrumentation, and define flight test plans.

W82-70144 **533-02-24**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
HIGH SPEED AIRCRAFT TECHNOLOGY (F-15)
Terrill W. Putnam 805-258-3311

The objective is to provide flight test support for high speed aircraft experiments. This will be accomplished by maintaining a baseline capability, with a high performance aircraft that can be easily used to accommodate specific flight projects or experiments. The baseline support will include contractor maintenance support, instrumentation system operation, basic maintenance, and fuel.

W82-70145 **533-02-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FLIGHT EXPERIMENTS F-14 HIGH ANGLE-OF-ATTACK
H. J. Smith 805-258-3311

The objective of this project is to conduct a number of flight test experiments in cooperation with the Navy and other NASA Centers which will benefit the F-14 while enhancing NASA's high angle-of-attack technology. These experiments include an evaluation of a control system modification, flying qualities investigation, high angle-of-attack parameter identification, simulation validation study, and an investigation of the F-14 air data system at high angles-of-attack.

W82-70146 **533-02-44**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
INTEGRATED RESEARCH AIRCRAFT CONTROL TECHNOLOGY
Berwin M. Kock 805-258-3311

The objectives are to develop, evaluate, and demonstrate a generically applicable design methodology for integrated airframe/propulsion controls. The approach will be to: demonstrate the viability of integrated airframe/propulsion controls to achieve system improvements; develop a flight hardware system capable of implementing advanced control concepts and algorithms; and establish an initial methodology to guide the design of more complex integrated airframe/propulsion control systems required in future vehicles. A test airplane will be modified, under contract, and used in a government flight research program to accomplish the project objectives.

W82-70147 **533-02-54**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
F-4C SPANWISE BLOWING FLIGHT TEST PROGRAM
R. G. Bryant 805-258-3311

This RTOP covers the flight test of the F-4C airplane, equipped with spanwise blowing, for a program that will permit DFRC, in cooperation with LaRC, to investigate several areas which can contribute to the basic research tasks in which NASA has a strong interest. The overall objective is to verify, through full scale flight tests, the low speed and transonic performance, and the flying qualities improvements predicted by analytical and wind tunnel studies for spanwise blowing. Factors not readily assessable in the wind tunnel will also be evaluated during the flight tests. These include the use of spanwise blowing for: control of low speed wing rock; alleviation of shock induced separation effects; high angle-of-attack; improved landing performance; and improved maneuverability.

W82-70148 **533-02-64**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FLIGHT TECHNOLOGY INTEGRATION/F-16
C. R. Jarvis 805-258-3311

The overall objective of the AFTI/F-16 program is to quantify the benefits and penalties of the individual and integrated technologies proposed to improve weapon system effectiveness and survivability by flight demonstration of air to air and air to surface offensive and defensive mission roles. The digital flight control system (DFCS), automatic maneuvering attack system (AMAS), and pilot vehicle interface (PVI) technologies are being implemented in a modified F-16 to allow flight evaluation of such nonclassical control modes as direct lift and side force, flat turn, fuselage pointing, and uncoupled independent control of aircraft rotation and translation. The AFTI/F-16 airplane will be flight tested and evaluated by a joint Dryden, USAF, and contractor flight test team and will be operated and maintained by Dryden from Dryden facilities.

W82-70149 **533-02-73**
Langley Research Center, Hampton, Va.
DECOUPLER PYLON FLIGHT DEMONSTRATION
R. C. Goetz 804-827-2042
(505-33-53)

A joint program between Langley Research Center and Dryden Flight Research Center has the objective to demonstrate the suppression of wing/store flutter using the decoupler pylon concept on an advanced high performance airplane. The concept has been verified in wind tunnel studies. The purpose of the flight studies is to subject the concept to the effects of the full flight environment including maneuvering and atmospheric gusts while assessing the alleviation of the store flutter problem and to evaluate the dynamic characteristics of the wing store decoupler pylon system. The decoupler pylon will be designed and fabricated under contract and flight tested at the Dryden Flight Research Center. The Langley Research Center will exercise technical management of the study.

W82-70150 **533-02-74**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
DECOUPLER PYLON FLIGHT TESTS
M. R. Barber 805-258-3311
(533-02-23)

In order to obtain maximum utilization of fighter aircraft, many different types and combinations of stores are pylon-mounted to the wings. The carriage of these stores can result in reduced flutter speeds or flutter placards with a corresponding degradation in mission effectiveness. The NASA Langley Research Center (LaRC) has been developing a pylon, the decoupler pylon, which suppresses wing/store flutter. The decoupler pylon dynamically isolates the wing from the store pitch inertia effects by means of soft spring and damper elements. Static pitch orientation of the store is maintained by a low frequency control system. The decoupler pylon has been shown to be effective in suppressing wing/store flutter by analyses and wind tunnel tests on a rectangular research wing and in transonic wind tunnel tests on the F-16 and YF-17 flutter models. These results have been very encouraging and NASA has defined a program to flight test the decoupler pylon. A feasibility study and a conceptual design have been conducted under contract establishing that the decoupler pylon concept can be implemented in flight hardware for testing on the F-16 aircraft. Flight tests of a decoupler pylon on an F-16 aircraft will be conducted under this RTOP.

W82-70151 **533-02-84**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FORWARD SWEPT WING
Terrill W. Putnam 805-258-3311

The objective is to provide technical advisory support, including quality assurance, NASA flight test instrumentation, and to plan and conduct the flight tests of the Forward Swept Wing aircraft for DARPA and its technical agent. Dryden will provide technical support through participation in design reviews, independent analyses, ground tests, flight certification and readiness reviews, and through the implementation of a high fidelity real-time piloted simulation at Dryden. Dryden will also provide approval of quality assurance plans and will provide proven flight test instrumentation from the Dryden inventory.

W82-70152 **533-03-13**
Langley Research Center, Hampton, Va.
HIGHLY MANEUVERING AIRCRAFT TECHNOLOGY
W. P. Henderson 804-827-2676

The objective of this research is to promote and stimulate the application of new and innovative technologies in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of the new technologies for the design of future fighter aircraft. The study of the highly integrated canard-wing concept will be pursued with the objectives of defining the stability and control characteristics at high angles-of-attack. Promising ideas for obtaining high aerodynamic performance for maneuvering fighter arcraft will be examined analytically and experimentally with primary emphasis on investigating their aerodynamic performance, propulsion, stability, and control characteristics. Representative promixing concepts which will be incorporated into the basic canard-wing concept include a high aspect ratio, two dimensional, vectoring nozzles utilized to provide control forces such that the large radar reflecting control surfaces can be eliminated. The experimental studies will be conducted in the Langley 16-Foot Transonic Tunnel.

W82-70153 **533-03-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY FLIGHT RESEARCH
P. C. Loschke 805-258-3311

This RTOP covers the flight test phase of a program to provide improved technology for the design of new advanced aircraft, with special emphasis on high maneuverability. Normal design practices were relaxed to permit complete freedom in the application of state-of-the-art systems such as fly by wire digital flight controls, composite structures, digital propulsion controls, and the like, in order to obtain maximum benefits from the combined interdisciplinary effects. The complex, high risk technology design of the HiMAT will be validated using the real and dynamic environment of flight. The high level of technical risks inherent in the HiMAT design precludes their application to manned aircraft due to pilot safety concerns and vehicle costs. Large scale, free flying powered models controlled by remote piloting techniques will be used to acquire flight test data at minimum costs.

Transport Aircraft Systems Technology

W82-70154 **534-03-13**
Langley Research Center, Hampton, Va.
COMPOSITE PRIMARY AIRCRAFT STRUCTURES
Robert C. Goetz 804-827-2042
(534-03-13; 534-03-33)

The primary objective is to develop technology for and accelerate the introduction of composite material in U.S. aircraft with a focus on wing and fuselage components of commercial transports. Studies under this RTOP will encompass the composites community thru grants, contracts, and in house research to develop tougher resin systems, improved processing methods, and to develop and validate analytical tools to predict performance of thick laminate wing structures and post buckling characteristics of thin laminate fuselage structures. Key technology issues facing the application of composites to wing structure, including critical joint, fuel containment, and durability/damage tolerance, will be addressed under contract to the major commercial manufacturers. Existing contracts with the commercial companies will continue to complete development of technology applicable to production of composite empennage structures.

W82-70155 **534-04-13**
Langley Research Center, Hampton, Va.
TERMINAL CONFIGURED VEHICLE PROGRAM
William D. Mace 804-827-3745
(505-34-13; 505-34-23; 505-34-33; 505-34-43; 505-35-23; 505-35-53)

The terminal configured vehicle program focuses on the need of conventional takeoff and landing transport aircraft to operate effectively in reduced weather minima in the high density terminal airspace environment using new navigation aids, surveillance and landing systems, and traffic management procedures being developed by the Federal Aviation Administration (FAA). The broad objective is to develop and evaluate advanced flight management concepts, procedures, control and guidance systems which, when applied to commercial aircraft, can improve airport and airway capacity, aircraft efficiency, and aircrew effectiveness. Research activity involves analysis, mission simulations, and flight studies using facilities at Langley, Wallops, FAA Technical Center, and FAA designated controlled airspace. Simulation facilities and a modified B-737 airplane, equipped with highly flexible display and control systems, are used to study operating systems and procedures in simulated future terminal area environments. The program includes active participation by major airframe manufacturers and cooperation with the FAA and airline representatives. The pilot interface with the microwave landing system, discrete address beacon systems, and operating elements such as collision avoidance, cockpit displayed traffic, and advanced traffic management procedures developed by the FAA will be studied.

Advanced Propulsion Systems Technology

W82-70156 **535-01-12**
Lewis Research Center, Cleveland, Ohio.
ENERGY EFFICIENT ENGINE PROJECT
Carl C. Ciepluch 216-433-6644
(511-54-01; 510-53-01; 505-04-02)

The objective of the energy efficient engine project is to

develop and demonstrate technology for a next generation turbofan engine having 10 to 15 percent lower specific fuel consumption, at least a 50 percent reduction in rate of performance deterioration, at least 5 percent reduction in direct operating cost, and reduced emissions and noise levels as compared to current high bypass turbofan aircraft engines. Initial program efforts included preliminary engine design and integration studies through contracts with two major aircraft engine manufacturers. On the basis of these studies and associated airframe and airline evaluations, engine cycles and configurations that best meet project goals were identified. The major part of the project was then initiated with award of parallel component development and integration contracts to the same two engine companies. These latter contracts emphasize the advancements in component and systems technologies required for possible future commercial development of more energy efficient engines. Advanced engine components are being designed and developed, and performance is being verified by rig tests. The high spool core system is being designed, fabricated, and will be tested to evaluate its performance characteristics and to further refine the design of the components. The low spool assembly integrated with the core will be used to evaluate two spool integrated performance and mechanical systems performance.

W82-70157 **535-03-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED TURBOPROP - INSTALLATION AERODYNAMICS
L. L. Presley 415-965-5851
(535-03-12; 535-03-13; 535-03-14)

The objective of this research is to support the development of the technology required to demonstrate the feasibiliy of advanced turboprop transport aircraft capable of cruise speeds and altitudes up to .8 Mach number and 35,000 feet. System studies will be conducted to analyze specific aircraft design tradeoffs. These studies will serve to determine the aircraft installation trades in terms of cruise speed, engine location, and propeller characteristics and thereby identify the most promising directions for future research. Through a combination of theoretical and experimental studies, the aerodynamic technology required to integrate advanced turboprop propulsion systems with transport aircraft using supercritical wing technology will be developed. Detailed flow interactions among the propeller slipstream, nacelle, and wing surface will be examined and methods identified to optimize the installation. Theoretical analyses will include existing linear methods and the development of an advanced method capable of handling the transonic slipstream-nacelle-wing interaction. Experimentally, the flow interactions will be investigated using: (1) a slipstream simulator to define the characteristics of the slipstream-supercritical wing interaction, and (2) a powered semispan model to provide an accurate simulation of the actual flow conditions.

W82-70158 **535-03-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP PROGRAM
G. K. Sievers 216-433-4000
(535-03-11; 535-03-13; 535-03-14)

The objective of the advanced turboprop program is to develop propeller and related drive system and aircraft technologies critical to efficient, reliable, and acceptable operation of advanced turboprop (prop-fan) powered aircraft. The present Phase II effort - 'large - scale structures', described by this RTOP, was initiated in FY-81 and is scheduled to be funded thru FY-85. The primary emphasis under this phase is the design, fabrication, and ground test of an advanced large scale propeller of 8 to 10 feet in diameter powered by an available gas turbine engine with a modified existing gearbox. Supporting anaysis and testing work is planned in the areas of propeller aerodynamics, acoustics, structures, dynamics, and in aircraft cabin environment (noise and vibration) and aircraft installation aerodynamics. Studies of advanced turboprop propulsion systems and components, and of advanced turboprop aircraft, missions, and applications, are also planned. Although NASA Lewis has overall management responsibility for the advanced turboprop program, other field centers will manage and conduct portions of the program that lie within their areas of capability and expertise. The major efforts planned by other centers are the measurement of installed aerodynamic performance (ARC), the inflight measurement of near field propeller noise (DFRC), and investigation of fuselage designs for low cabin noise with minimum weight penalty (LaRC). It is intended that the present Phase II program lead to the final Phase III effort - 'Systems Integration', where the propeller and propeller drive system generated by the Phase II effort will be tested in flight using a specially modified test bed aircraft.

W82-70159 **535-03-13**
Langley Research Center, Hampton, Va.
ADVANCED TURBOPROP - INTERIOR NOISE
R. C. Goetz 804-827-2042
(505-32-03; 505-33-53; 505-35-13; 505-41-43; 505-42-13; 532-06-13)

The objective of this program is to demonstrate technology readiness in the area of acoustics and noise reduction for advanced turboprop aircraft development. Configurations of interest are powered by highly loaded, multibladed turboprops for efficient, high speed operation. Emphasis is on propeller noise and cabin interior noise environment. Improved analytical and experimental methods for predicting prop-fan noise both in the near field and far field, for predicting the transmission of noise through the cabin sidewall, and for predicting the contribution of structure borne noise to the cabin interior noise environment are being developed. These prediction methods were developed by means of model tests during the Enabling Technoloy Phase I of the program. Criteria for passenger and community acceptance are also being developed by defining and quantifying factors which affect human response to advanced turboprop noise and vibration, in order to demonstrate technology readiness. The improved prediction methods and criteria will be used to guide the design of low weight, high attenuation sidewalls for passenger acceptance and the design of propfans for acceptable fuselage/structure as well as community noise exposure. The sidewall, structure, and propeller configurations resulting from acoustic consideraions will be validated by large scale testing in the advanced technology Phase II of the program and flight tests during Phase III of the program.

W82-70160 **535-03-14**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED TURBOPROP FLIGHT RESEARCH
R. S. Baron 805-258-3311

The objective is to develop and demonstrate by flight research the technology for advanced turboprop propulsion systems having high propulsion efficiencies at cruise speeds and altitudes up to Mach 0.8 and 35,000 feet. This technology could provide fuel savings of 15 to 25 percent relative to advanced high bypass turbofan engines while meeting reliability requirements and environments noise constraints. A two foot diameter scale model of an advanced high tip speed propeller will be installed on a JetStar aircraft capable of flying Mach .8 at 35,000 feet altitude. Microphones will be placed on wing and fuselage and acoustic flight research will be performed to obtain near field noise data.

Space Research and Technology Base

Aerothermodynamics Research and Technology

W82-70161 **506-51-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
J. G. Marvin 415-965-5390
(506-54-41; 506-51-41)

The objective of this RTOP is to establish aerothermodynamic technology and configuration design concepts to improve vehicle safety, reliability, versatility, and aerodynamic efficiency with

maximum payload for Earth orbital missions and planetary exploration. Advanced computational methods and computer codes will be developed for predicting vehicle flow fields and performance. Turbulence models (used in these computer codes) will be developed from 'building block' numerical and physical experiments. New instrumentation techniques will be developed for the measurement of turbulence quantities in three-dimensional flow fields.

W82-70162 **506-51-13**
Langley Research Center, Hampton, Va.
SPACE VEHICLE AEROTHERMODYNAMICS AND CONFIGURATION TECHNOLOGY
J. P. Arrington 804-827-3911

The objective of this study is to develop configuration design concepts and the associated aerothermodynamic technology data base which will allow the achievement of space transportation vehicles operational in the 1990's and beyond which offer significant improvement in vehicle capabilities, reliability, versatility, and aerodynamic efficiency and operational efficiency, economy, and safety. The intent is to study, both analytically and experimentally, configuration concepts utilizing technologies advanced beyond the base being established by the space shuttle. Specific studies will be directed toward solution of the aerothermodynamic problems associated with these concepts in such areas as aerodynamic performance, viscous-interaction and real-gas effects, vortex interactions, heat transfer, basic configuration shaping, and optimization. Computational flow-field methods with emphasis on realistic configurations, and techniques for integrated configuration design, analysis, and optimization will be developed and continuously improved. Feasibility studies of the use of the Space Shuttle Orbiter to obtain fundamental aerothermodynamic data applicable to future vehicle design will be pursued. Various facilities will be utilized in experimental investigations to provide design data over a broad range of parameters.

W82-70163 **506-51-21**
Ames Research Center, Moffett Field, Calif.
PLANETARY PROBE AEROTHERMODYNAMIC TECHNOLOGY
H. K. Larson 415-965-5369
(506-53-31; 506-51-41)

This effort is directed at providing the aerothermodynamic technology base in high-speed aerothermodynamics required for the design, development, and verification of probes entering planetary atmospheres and to provide computational and experimental support, in a timely manner, for the specific development of planned and approved missions. The objectives include the following: (1) prediction of the shock layer and ablation product radiative gasdynamics for planetary entry vehicles; (2) coupled flow field ablation solutions for outer planet probes; and (3) the aerodynamic development of planetary probe configurations and the flight mechanics data in support of atmospheric reconstruction experiments. The coupled nature of outer planet probe aerothermodynamics requires a highly integrated computational and experimental program. The theoretical and experimental efforts in the area of shock-layer radiation must be coupled with similar efforts in ablation product radiation and absorption. These efforts in turn must be coupled with research associated with shock layer flow which is highly blown by ablation products. In addition, the flight mechanics of the probe, both static and dynamic, are significantly affected by the ablation mass loss and shape change. Finally, all these theoretical efforts and experimental validations must provide the required aerothermodynamic input to outer planet probe development.

W82-70164 **506-51-23**
Langley Research Center, Hampton, Va.
PLANETARY PROBE TECHNOLOGY
J. J. Jones 804-827-3031
(540-04-15; 540-02-15; 540-04-15)

This work encompasses computational and experimental support for advanced mission planning of future planetary entry vehicles as well as direct support for approved missions. The nature of the work is prediction of the flow-field environment, expected aerodynamic heating rates, and aerodynamic forces for proposed missions and vehicles. While the mission support is developmental in nature, aimed at specifying heat shield requirements and aerodynamic performance for a given configuration, the work for future missions is more fundamental-analyzing thermodynamic and transport properties of various gases, developing computational techniques for viscous and noncontinuum flows or techniques for flow-field computations over new configuration classes. Work is primarily performed in house, supplemented by contractual assistance in some areas. FY 1982 activities will focus on aerobraking and aerocapture aerothermodynamic requirements.

W82-70165 **506-51-31**
Ames Research Center, Moffett Field, Calif.
OEX FLIGHT DATA ANALYSIS
H. K. Larson 415-965-5369
(506-63-35; 506-63-36)

This effort is directed to provide the gasdynamic and aerothermodynamic technology base that is required to analyze the aerothermodynamic data of flight origin from Shuttle, Shuttle launched entry research vehicles, and engineering experiments on NASA atmospheric entry missions to improve aerothermodynamic design techniques for new vehicles and to enhance the aerothermodynamic efficiency of the Shuttle. This will be accomplished by addressing the following targets: (1) comparison of data from infrared imagery of Shuttle (IRIS) and development flight computations with Shuttle design techniques and advanced flow field computations; (2) reduction of Shuttle flight data into engineering units for the Catalytic Surface Effects and the Tile Gap Heating Effects experiments; (3) comparison of data from the Catalytic Surface Effects and Tile Gap Heating Effects experiments with advanced Orbiter flow field calculations; and (4) comparison of data from shuttle Infrared Leeside Temperature Sensing (SILTS) experiment with advanced leeside flow field computations.

W82-70166 **506-51-33**
Langley Research Center, Hampton, Va.
AERODYNAMIC/AEROTHERMODYNAMIC FLIGHT DATA ANALYSIS
J. J. Jones 804-827-3031

The objectives of this work are to carry out analyses of aerodynamic and aerothermodynamic flight data and to compare the results with pertinent ground test data and theoretical predictions; to assess the adequacy and accuracy of theory and the techniques used to extrapolate wind tunnel data to flight conditions; to define areas where improved methods, facilities, or additional flight data are needed; and to identify areas for significant improvements in future Space Shuttle Orbiter modifications. Shuttle orbiter data will be analyzed for each of the developmental flights, making use of as much instrumentation data as are available. Trajectory and atmospheric data will be processed to yield vehicle state parameters. Thermocouple, calorimeter, and pressure transducer data will be used to extract heating and pressure distributions. Accelerometer data will be used to estimate aerodynamic forces. As OEX experiment data become available, they will be used to expand and improve the quality of the flight performance assessment.

W82-70167 **506-51-34**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
SPACE SHUTTLE AERODYNAMIC EXPERIMENTS
T. G. Ayers 805-258-3311

The use of Shuttle Entry Air Data System (SEADS) type flush mounted pressure orifice and auxiliary flush orifices for air data measurements at subsonic and transonic speeds will be investigated. The applicability of currently available mathematical tools for determination of digital flight control system, stability and control, performance, structural and atmospheric turbulence characteristics in the reentry environment, will be extended.

W82-70168 **506-51-41**
Ames Research Center, Moffett Field, Calif.
OPERATION OF THERMO-GASDYNAMIC FACILITIES
F. H. Nichols, Jr. 415-965-6075
(505-31-11; 506-51-11; 506-51-21; 506-53-31; 506-63-36)

This RTOP covers support and operation of the high energy facilities at Ames which include: the Arc-Jet Complex (Aerodynamic Heating Tunnel, 2x9 Turbulent Flow Duct, 20-MW Panel Test Facility, 60-MW Interaction Heating Facility, Transitional Flow Facility, High Enthalpy Entry Facility, Giant Planet Facility, High Power Gas-Dynamic Laser); 3.5-Ft. Hypersonic Wind Tunnel; High Reynolds Number Channels 1 and 2; Ballistic Range Facilities; and the Electric Arc Shock Tube Facility. The objective of this effort is to provide aerodynamic and thermal testing in support of research and technology programs for NASA, Department of Defense, other government agencies, and industry. Program areas supported include generic research applicable to spacecraft thermal protection systems, configuration design of both aircraft and spacecraft, and prediction of flight vehicle flow fields. Flight vehicle and component research and development and thermal protection systems evaluations are supported for other NASA Centers, DoD, and industry. Space Shuttle design, development, and verification tests are extensively supported in the areas of thermal protection and vehicle configuration. The thermal protection system for the Galileo Probe and OEX materials evaluations are also extensively supported in the facilities. In addition, tests are performed for systems technology programs including the MX missile system, advanced thermal protection systems, laser hardening of missiles, and nuclear power pack safety.

Chemical Propulsion Research and Technology

W82-70169 **506-52-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED OXYGEN-HYDROCARBON EARTH-TO-ORBIT PROPULSION
Richard J. Priem 216-433-4000

Advanced high pressure oxygen-hydrocarbon rocket engines are being investigated for application as main propulsion systems for future booster vehicles. Chemical Propulsion technology will be extended in the areas of performance, operational life, multiple reuse, maintainability and serviceability in order to enable the development of future vehicles that will operate reliably at low recurring cost. This effort will emphasize thrust chamber cooling, heat transfer, performance and stability. This will be accomplished through studies involving data screening, analysis, design, computer modeling and subscale testing.

W82-70170 **506-52-17**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED MANNED VEHICLE ONBOARD PROPULSION TECHNOLOGY
R. W. Polifka 713-483-5437

The objective of this effort is to identify viable propulsion systems designs and propellant alternatives which could replace N2O4/MMH in a second generation shuttle auxillary propulsion system or similar advanced spacecraft propulsion systems and to establish the technology base necessary to allow for future systems development. Phase out of N2O4/MMH may become necessary due to handling health hazards, high propellant cost, and high corrosivity of these propellants. The oxygen-hydrocarbon propellant family provides the most attractive alternative. Oxygen-hydrocarbon type propellants will be characterized and system design and trade studies conducted. Propellant and design selections will be made and critical component technology and technology issues will be identified. Component technology will be developed and carried forward into assembly level test evaluation.

W82-70171 **506-52-19**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED REUSABLE OXYGEN - HYDROCARBON MAIN ENGINE TECHNOLOGY
R. J. Richmond 205-453-3710

Advanced high pressure oxygen-hydrocarbon rocket engines are being investigated for application as main propulsion systems for future booster vehicles. Single-fuel and dual-fuel, dual-throat engine concepts are being examined. These activities include engine power cycle synthesis, parametric data generation, component performance prediction and evaluation, injector/combustor design and fabrication and combustor and turbine cooling investigations. These efforts include data screening, analysis, design, computer modeling, hardware fabrication, data evaluation and test.

W82-70172 **506-52-25**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH ENERGY CHEMICAL PROPULSION TECHNOLOGY FOR PLANETARY SPACECRAFT
T. W. Auslander 213-354-4413
(506-52-35; 506-53-36)

The overall objective of this RTOP is to provide a technology base for autonomous, long-life propulsion systems for advanced planetary spacecraft. The RTOP is divided into three major tasks as follows: Advanced Pump-Fed Propulsion - This effort will provide the technology base for a pump-fed propulsion system which employs a cryogenic oxidizer. The approach includes mission analyses and generic pump hardware research. A small motor-driven pump-set will be utilized to demonstrate technology readiness in earth storable propellants and to confirm research requirements with the cryogenic oxidizers. Research supporting this technology includes materials compatibility, exhaust plume characterization, hydrogen refrigeration, cryogenic oxidizer components technology and, non-hypergolic ignition technology. Autonomy in Propulsion - This effort will develop the technology necessary to permit spacecraft propulsion systems to operate with high reliability and fault tolerance without ground control for extended periods. Initial efforts will focus on identifying necessary technology developments with emphasis on support of pump-fed, cryogenic systems. Energetic Solid Propulsion - The objective is to add to the technology base of a solid propulson system which incorporates an energetic HMX nitramine oxidizer, and to tailor a non-HMX, high solids, high energy propellant system. The approach will involve a combination of study and experimentation, including complete motor testing. Experimentation involves processability, ballistics, aging stability, thermal stability and combustion stability of the propellants which use HMX oxidizers. Mission surveys will be done to identify application problems, which will be used to direct future solid propulsion activities.

W82-70173 **506-52-30**
National Aeronautics and Space Administration, Washington, D.C.
CHEMICAL PROPULSION R&T INTERAGENCY SUPPORT
F. Stephenson 202-755-8503

The primary objective of this activity is to maintain a continuous up-to-date information gathering capability on the nation's total chemical propulsion technology efforts as an aid in planning and implementing the NASA program. In addition, joint interagency tasks are undertaken when appropriate, such as publishing handbooks, manuals or computer models, that will be beneficial to the propulsion community as well as other potential users. The approach is to share support of the Chemical Propulsion Information Agency (CPIA), which supplies information gathering and dissemination services, with the DOD agencies through the Joint Army, Navy, NASA, Air Force (JANNAF) Interagency Propulsion Committee. For special interagency tasks, funding is transferred to the agency designated as responsible for the procurement action and contract monitoring.

W82-70174 **506-52-35**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CHEMICAL PROPULSION CONCEPTS FOR PLANETARY SPACECRAFT
T. W. Auslander 213-354-4413
(506-52-25; 506-62-55)

The overall objective of this RTOP is to provide technology for advanced concepts for propulsion for planetary spacecraft. The first task, ultra high performance chemical propulsion, forms the basis of a continuing effort to identify, evaluate, select, and demonstrate new concepts for planetary spacecraft propulsion. The objective of this effort is to enhance or enable future planetary missions by significantly reducing the required trip times and/or increasing the available payloads relative to that provided by state of the art propulsion systems. Advanced concepts (such as metastable compounds, free radicals, atomic combustion, and electrical/thermal augmentation) will be evaluated and concepts which offer significant performance gains will be identified. Technology development requirements for these concepts will be defined, and planning and proposals for the resolution of these issues will be generated. The second task, autonomous systems using in-situ produced propellants, will establish technology for production and utilization of propellants produced in-situ using resources indigenous to selected extraterrestrial bodies. Because of reduced Earth launch requirements enabling missions can result which use in-situ manufactured propellants for planetary takeoff, return to Earth, or refueling stations. A laboratory demonstration of the extraction of oxygen from the Martian atmosphere (95.3% CO2) and the synthesis of fuels from appropriate raw materials is in progress with concurrent mission studies concurrently to identify propellant production on other planetary/satellite target bodies besides Mars. Completion of the laboratory demonstration of oxygen production will be the end of FY-83. After 1983 program emphasis will be directed toward autonomous operation of the propellant production plant return vehicle components.

W82-70175 **506-52-42**
Lewis Research Center, Cleveland, Ohio.
ADVANCED VARIABLE THRUST AND LOW THRUST ORBITAL TRANSFER PROPULSION
Richard J. Priem 216-433-6225
(506-52-49)

The objective is to provide technology for improving performance, life and reusability of future highly versatile liquid chemical rocket engines in order to greatly extend mission capability and flexibility in performing orbital operations reliably and at reduced operating costs. The propulsion systems that will be investigated include a highly versatile, throttleable, reusable and maintainable high thrust rocket engine; a high performance low-thrust expendable rocket engine; and a small high performance attitude control and station keeping rocket engine. Emphasis of the work will be on: combustion, cooling and heat transfer; performance enhancements; long life turbomachinery; simplified servicing and maintenance; automated monitoring and diagnostic techniques; lightweight reusable components; small high performance combustors and pumps; high expansion area nozzles; and long life, high performance attitude control propulsion.

W82-70176 **506-52-49**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED ORBITAL TRANSFER PROPULSION PERFORMANCE AND PLUME CHARACTERIZATION
R. J. Richmond 205-453-3710

Advanced reusable oxygen/hydrogen engines required for future orbit to orbit vehicles are being investigated. The activities described include advanced engine power cycle analysis and synthesis, technology identification and acquisition, component and system performance prediction model improvement. These efforts include computer modeling, data screening, analysis, hardware fabrication, test, and evaluation. Both low and high altitude plume flow field computer programs are being developed employing new technology in flow field methodology where applicable. These programs will not be restricted to hydrogen/oxygen but will be applicable to all currently envisioned propellant systems. In addition to the flow field programs, a state-of-the-art high altitude plume impingement analysis will be developed.

W82-70177 **506-52-62**
Lewis Research Center, Cleveland, Ohio.
ADVANCED HIGH-PRESSURE OXYGEN-HYDROGEN PROPULSION LIFE AND PERFORMANCE TECHNOLOGY
Richard J. Priem 216-433-4000
(506-52-69)

The SSME program was a pioneer in rocket engines because of the high pressure, staged combustion cycle, variable thrust, closed loop control, and the requirement for reusable long life hardware. However, its development and qualification were not without problems and further improvements are necessary to provide increases in the space shuttle performance or to reduce the recurring cost per flight. The technology level available on which the SSME is based is capable of advancement to upgrade the current engine and improve the performance and capability of the space shuttle. The overall technical objective of this effort is to evaluate the level of technology applicable to the SSME so that performance, life, and operating improvements to the SSME and its elements can subsequently be defined and developed. These improvements would provide a basis for upgrading the performance and capability of the space shuttle or reducing the recurring cost per flight. The efforts will emphasize the definition and demonstration of the technology for designs, techniques, procedures, and data necessary for performance uprating, long life, and low cost maintenance and between flight checkout.

W82-70178 **506-52-69**
Marshall Space Flight Center, Huntsville, Ala.
TECHNOLOGY FOR ADVANCED O2/H2 EARTH-TO-ORBIT PROPULSION
S. F. Morea 205-453-3908
(506-52-62)

The space shuttle main engine (SSME) program has been a pioneer in rocket engines because of the high pressure, staged combustion cycle, variable thrust, closed loop control and the requirement for reusable, long life hardware. However, its development and qualification have not been without problems and further improvements are necessary to provide increases in the Space Shuttle performance or to reduce the recapable of advancement to upgrade the recurring cost per flight. The technology level available on which the SSME is based on current engine and improve the performance and capability of the space shuttle. The overall technical objective of this effort is to advance the level of technology applicable to the SSME so that performance, life and operability improvements to the SSME and its subsystems can subsequently be defined and developed. These improvements would provide a basis for upgrading the performance and capability of the space shuttle or reducing the recurring cost per flight. The efforts will emphasize the definition and demonstration of the technology for designs, techniques, procedures and data necessary for performance uprating, long life and low cost maintenance and between flight checkout.

Materials and Structures Research and Technology

W82-70179 **506-53-11**
Ames Research Center, Moffett Field, Calif.
SURFACE PHYSICS AND COMPUTATIONAL CHEMISTRY
J. O. Arnold 415-965-6209

The objective is to develop a detailed understanding of the mechanisms which control important properties of matter over a wide range of environments. This understanding is leading to the development of new materials and processes needed by the agency. Work is proceeding in the areas of surface physics and computational chemistry. In surface physics, properties of metallic interfaces are being determined by probing their structure at the atomistic level. High lateral and depth resolution chemical analysis by Auger electron spectroscopy is used to measure the

compositional structure of high temperature metallic corrosion scales. Knowledge of surface/environment interactions is being improved by studying chemisorption and surface reactions on microscopic (single crystal) and macroscopic (cluster) metal surfaces. Work is underway on the interaction of electron beams with gaseous adsorbates on well defined metal surfaces. In computational chemistry, the physical and chemical properties of molecules and small atomic clusters (5 to 14 atoms) are being calculated using state-of-the-art wave function computer codes. These quantum mechanical results for the small atomic clusters are extrapolated by classical mechanics to determine surface and bulk properties of materials. Improvements in precision, code optimization, and approximate methods are allowing larger systems to be studied, thus requiring smaller extrapolations to obtain surface and bulk properties. This also helps to elucidate the manner in which properties of atomic clusters approach those of the bulk material. These calculations are currently being used to investigate chemisorption, diffusion, corrosion, hydrogen induced crack growth, and the properties of catalytic particles.

W82-70180 **506-53-12**
Lewis Research Center, Cleveland, Ohio.
MATERIALS SCIENCE
C. Lowell 216-433-4000
(506-33-32; 505-33-12)

The objectives of this RTOP are to develop greater understanding of materials with aerospace propulsion and power potential and to thereby develop guidelines for improving their physical and mechanical properties. Fundamental studies are aimed at determining the mechanisms limiting material performance and useful life as well as at identifying scientific concepts which might be applied to substantially improve such materials. Research includes understanding of: compositional effects on aluminide toughness; metallic and ceramic composite strengthening mechanisms; processing/microstructural relationships to superalloy mechanical properties; and the basics of friction, wear, and adhesion and the chemistry and morphology of solid lubricants.

W82-70181 **506-53-15**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTALS OF MECHANICAL BEHAVIOR OF COMPOSITE MATRICES
A. Gupta 213-354-5783

The long term objective of this RTOP seeks to develop a fundamental understanding at the molecular level of the behavior of polymeric organic matrix materials with major emphasis on composite matrix materials, used in current and planned space and primary airframe structures. Applications for this research are aimed at the evaluation of long term performance of advanced composites as well as of the adhesively bonded interfaces and will support the development of large area space structures, spacecraft, and advanced space transportation systems. From correlations of molecular parameters with observed mechanical properties and failure mechanisms of matrix materials and composites, strategies will be developed for seeking molecular structures of polymers and composite systems which would exhibit higher performance, longer life and lower cost. The effort involves two tasks. The first task concerns thermoplastic polymers. The objectives for FY-82 are to determine the molecular origins of mechanical properties in the glassy state and to initiate characterization of molecular relaxation mechanisms and their dependence on physical aging. Approach involves determination of mechanical response and molecular relaxation processes as a function of morphology, process history, and physical aging. The second task involves thermosetting polymers. The FY-82 objective is to determine the curing kinetics, characterize the network topology, and initiate work on characterizing the mechanical properties of amine cured epoxy resins. Approach will involve identification of reaction mechanisms as a function of temperature and resin formulaton, and characterization of network crosslink density and viscoelastic properties.

W82-70182 **506-53-17**
Lyndon B. Johnson Space Center, Houston, Tex.
REFINING OF NONTERRESTRIAL MATERIALS
R. J. Williams 713-483-2781

These studies are designed to provide data on chemical and physical processes which might be used to extract metals, gases, and glasses from lunar rocks and soils for ultimate use in constructing and supporting space projects. Laboratory experimentation will be used to study some processes by which potentially useful materials may be extracted from or formed from lunar rocks and soils. These studies will be confirmed to the laboratory scale at the bench-top and will concentrate on the determination of basic physical or chemical properties which define and quantify processes. Effort will be concentrated into two areas of study: (1) electrostatic and electromagnetic processes for mineral separation and (2) glass, foamed glass, and glass composite manufacture.

W82-70183 **506-53-23**
Langley Research Center, Hampton, Va.
COMPOSITES FOR ADVANCED SPACE SYSTEMS
R. C. Goetz 804-827-2042
(505-33-33; 505-33-23)

The objective of this research is to define and develop composite materials that have the potential of improving the performance and reducing the costs of space structures and space transportation systems. Current emphasis is being placed on establishing the performance capability of composite materials in the radiation environment of space, continued development of graphite/polyimide composites for high temperature space applications, and understanding the mechanical behavior of composites to improve their damage tolerance. Current and advanced resin matrix composites will be subjected to laboratory simulated space radiation (proton, electrons, UV, etc.) to establish overall composite material performance and to identify radiation damage mechanisms. These studies will serve as a guide to develop models to predict material performance in the space environment and to evolve more radiation resistant materials. A basic understanding of the cure mechanics of high temperature graphite/polyimide composites will be established to provide for optimum and reproducible fabrication of structural components. A generic methodology will be established for prediction of the fracture strength of composites along with concepts and analyses to achieve improved damage tolerance such as the use of buffer strips. A significant portion of this research is directly related to Large Space Antenna Technology Focus established at Langley.

W82-70184 **506-53-25**
Jet Propulsion Laboratory, Pasadena, Calif.
EFFECTS OF SPACE ENVIRONMENT ON COMPOSITES
A. Gupta 213-354-5783

The long range objective is to utilize ultrafast pulse radiolysis to gain an understanding of primary degradation processes caused by charged particles in composite materials and to ultimately use this information along with conventional high energy exposure material test data to develop a reliable methodology for estimation of the long term effects of space environment on polymers and composites. The objectives for FY-82 are to continue development and validation of radiation stabilization techniques and predictive model for charged particles degradation of candidate materials, to generate data on the effects of electron beam excitation of polyimides, and to initiate pulse radiolytic studies on polymeric and composite materials using pulsed proton beams. Transient measurements following pulse radiolysis will be used to determine rates of fast processes such as dissociation of primary intermediates, generation and decay of excited states resulting from ion recombination or other secondary processes, and radical formation and disappearance. Pulse radiolysis, utilizing pulsed electron or proton beams in conjunction with fast optical and esr detection assemblies can monitor these types of fast processes and measure their rates. Craze and crack formation resulting from charged particle irradiation and leading ultimately to material failure will also be investigated. These data, along with conventional steady state data will be used to develop

analytical models of degradation and a reliable prediction technology for 20 year lifetime applications.

W82-70185 **506-53-31**
Ames Research Center, Moffett Field, Calif.
THERMAL PROTECTION SYSTEMS MATERIALS AND SYSTEMS EVALUATION
H. K. Larson 415-965-5369
(506-51-21; 506-51-41; 506-63-36)

The objective is to provide thermal protection systems (TPS) concepts and materials for heat shields to protect Earth and planetary entry vehicles and planetary probes during atmospheric entry. The specific objectives are to: (1) develop improved fiber materials and minimum weight TPS to enhance the space shuttle and enable fully reusable advanced space transportation systems development; (2) develop planetary probe heat shield materials and determine methods to minimize heat shield weights; (3) develop concepts and heat shield materials for safe Earth entry of radioactive power sources and to support DoD requirements; and (4) develop concepts and materials for solar probe heat shields. The system requirements for each end use are defined. Thermal protection materials parameters are determined that meet these requirements. Materials are either selected from the extensive technology in existence or new materials with optimized properties are developed. Candidate thermal protection concepts and materials are subjected to systematic analysis and testing to qualify them for the defined end use. Extensive unique Ames arc plasma test facilities developed for space shuttle and planetary entry probes are used in the experimental evaluations. Analytical studies are performed utilizing unique environmental computer codes developed by ARC that include detailed models of both the aerothermal environment and material response to obtain in-depth understanding of the material characteristics. Materials are often developed as a result of these studies to meet the ever more stringent requirements for atmospheric entry thermal protection.

W82-70186 **506-53-33**
Langley Research Center, Hampton, Va.
THERMAL PROTECTION SYSTEMS FOR EARTH-TO-ORBIT STS
R. C. Goetz 804-827-2042
(506-53-43; 506-53-63; 506-63-38)

The objectives of this research are to provide thermal protection systems materials and concepts for advanced space transportation systems (STS) that provide improved durability and operational costs compared to the current LI-900 and LI-2200 RSI systems. Heat shield testing support to the current STS program will be provided and improvements in the structural performance of current (LI-series and FRCI) ceramic systems will be developed. Materials research includes development, characterization, and enhancement. Development efforts will be focused on fabricability in thin gages of ODS alloys and advanced carbon-carbon (ACC). Characterization efforts will be focused on foil gage titanium, ODS alloys and superalloys, and thin gage ACC. Enhancement efforts will be focused on emittance, creep, oxidation and strength for titanium, superalloys, and ACC. Concepts research includes metallic pre-packaged and ACC post supported standoff concepts. These concepts will be evaluated in various Langley high temperature wind tunnels and will be subjected to other types of tests such as foreign object impact and radiant heating. Arc tunnel and other facilities will be used as required to validate and certify space shuttle TPS for multimission use. In addition, design, analysis and test functions will be carried out to improve and/or certify the structural performance of LI-series and FRCI ceramic TPS.

W82-70187 **506-53-37**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED CARBON - CARBON PANELS
D. M. Curry 713-483-2375

This RTOP provides for the design, development, and evaluation of carbon-carbon panels for both general acreage and specific high temperature areas of the shuttle orbiter. The advanced carbon-carbon material developed by the Vought Corporation under a NASA/Langley contract will be used as the baseline material. The results of these studies will evaluate the advanced carbon-carbon panels with respect to the baseline orbiter RSI TPS in terms of weight, cost, performance, and maintainability, and form the basis for studies of the application of ACC TPS to orbital transfer vehicles and future launch/entry vehicles.

W82-70188 **506-53-39**
Marshall Space Flight Center, Huntsville, Ala.
THERMAL PROTECTION SYSTEM
J. L. Vaniman 205-453-1171

Space vehicles envisioned during the operational phase of the space transportation system (STS) will require thermal control in magnitudes and configurations beyond the capability of current technology. Development of new system concepts, as well as new components, will be required, in a timely fashion, to meet the needs of these vehicles. The purpose of the tasks described in this research and technology effort is to develop components which will be vital to future thermal control systems (TCS). Upon completion of component design, fabrication, and testing, TCS elements will be integrated at the breadboard level to evaluate system performance and life characteristics.

W82-70189 **506-53-43**
Langley Research Center, Hampton, Va.
ADVANCED SPACE STRUCTURES
R. C. Goetz 804-827-2042

Research will be conducted on structures for future spacecraft and advanced space transportation systems. Work areas include development of new structural concepts together with appropriate analysis and design techniques, prediction and control of dynamic response and development of experimental techniques for validation of concepts and theory. Concepts for improving the reliability of large deployable structures by using sequential deployment will be investigated. The use of slender struts to achieve high density packaging will be studied, as well as concepts for precision reflectors using either truss or tension stiffened structures. Dynamic response prediction and damping techniques for new concepts will be investigated and experiments conducted to confirm behavior. For advanced space transportation structures, concepts for integral tankage will be investigated, as in-house studies of advanced configurations evolve. Basic dynamic studies of system identification, mathematical model improvements and nonlinear response will be conducted to improve experimental test techniques.

W82-70190 **506-53-53**
Langley Research Center, Hampton, Va.
ANALYSIS AND DESIGN
R. C. Goetz 804-827-2042
(505-33-63)

The objective of this research is to develop integrated multidisciplinary analysis and synthesis methodology with emphasis on applications to space transportation systems; some effort will be focused on large space structures. Analysis efforts will focus on improved structural heat transfer aiming at an integrated thermal/structural analysis capability based on finite element methods. Multidisciplinary studies will initially involve the space shuttle orbiter with tip-fin controllers and will evolve into studies of advanced space transportaion systems.

W82-70191 **506-53-63**
Langley Research Center, Hampton, Va.
AEROTHERMAL LOADS
R. C. Goetz 804-827-2042

The primary objective of this effort is to identify and understand flow phenomena and flow/surface interaction parameters required to define detailed aerothermal loads for structural design. The secondary objective of this effort is to develop and validate analysis and test methods for the prediction and verification of structural response in thermal environments for use in the support of design, optimization and qualification of space tranportation systems. Heating and pressure effects on space transportation system structures will be investigated. Effects of wavy surfaces, coves, gaps, wing/body and wing/elevon junctions will be studied in wind tunnel tests. Selected problems will be studied analytically. Some effort will also be focused on

mass addition cooling effects on flow phenomena with initial emphasis on conical shapes.

W82-70192 **506-53-64**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
LOADS, DYNAMICS AND AEROELASTICITY
A. L. Carter 805-258-3311

Experimental data from flight and laboratory tests of high temperature structures will be obtained and used to: (1) develop strain gage load measurement techniques; (2) evaluate state-of-the-art analytical methods; and (3) demonstrate new structural concepts.

W82-70193 **506-53-65**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE VEHICLE DYNAMICS METHODOLOGY
J. A. Garba 213-354-2085

The long term objective is to perform basic research in structural dynamics related to future NASA space missions. The structural dynamics research includes the improvement of prediction techniques for low frequency payload dynamics; the advancement of methods for the correlation of analysis with test data; the development of methods for the analysis of large complex nonlinear structural systems by applications of new computer technology; and the identification of requirements for research for future NASA space missions. Over the last few years tools have been developed for the cost effective prediction of payload loads. Some of the technology developed is currently being used to obtain structural loads for the Galileo (GLL) and the International Solar Polar Mission (ISPM) spacecrafts. The experiences gained with some of these methods are summarized in publications in the open literature. An analysis/test correlation method has also been developed and reported in the open literature. The approach in FY-1982 will be to continue the search for cost effective loads analysis methods and to evaluate the methods developed to date, using flight data wherever possible. Improvements for correlating analysis results with test data will be sought. The development of nonlinear analysis tools for potential future missions will be continued using numerical examples to evaluate methods derived previously. The activities in this RTOP will be coordinated with NASA Headquarters, other NASA centers, and the Dynamic, Acoustic, and Thermal Environment (DATE) Working Group chaired by GSFC. The task will utilize shuttle orbiter bay flight data from various flight programs.

W82-70194 **506-53-66**
Goddard Space Flight Center, Greenbelt, Md.
PAYLOAD ENVIRONMENTS AND DYNAMICS
J. P. Young 301-344-8284
(506-63-39)

The overall objectives are to produce improved techniques for deriving vibroacoustic and transient environment design and test specifications for STS payload components and to produce improved techniques for combining STS lift-off vibroacoustic and transient response environments and loads. The approach is to exercise/validate the VAPEPS program for data storage/retrieval and prediction of vibroacoustic environments for STS payload components through the use of STS flight data, to validate the PACES program for predicting STS payload bay acoustic environment by correlating measured flight acoustic data with predictions, to obtain/evaluate STS payload flight data specifically suited for verifying payload design loads and environmental prediction methods, to plan and manage the acquisition, processing and utilization of STS payload data via the DATE Working Group, and to evaluate the importance of vibroacoustic induced loads with respect to lift-off low frequency transient induced loads on payload design. Improved means for developing/evaluating payload design and test criteria for STS vibroacoustic and lift-off transient environments will be provided. Within FY-1982, the PACES and VAPEPS programs will be validated based on STS-1, STS-4 flight data. The STS flight data and ground test data will be evaluated for development of a combined vibroacoustic and transient response payload design loads criteria.

W82-70195 **506-53-69**
Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE DYNAMICS
R. S. Ryan 205-453-2481

The objective is to continue to develop techniques for predicting dynamic response, combining loads, and optimizing systems dynamics of space transportation systems and payloads. Several ongoing tasks are already contributing to the accomplishment of these objectives. The objectives of these tasks are: (1) to further develop the SPAR structural dynamic/fluid dynamic computer program to meet the requirements of spacecraft projects; (2) to perform acoustical analyses to develop a unified approach for predicting Shuttle payload bay acoustical environments; and (3) to develop 'shortcut' methods for payloads assessment. Additional tasks are being added and their objectives are to develop methods for: (1) optimal configuration control for large space systems; (2) combined loads criteria for complex space vehicles and payloads; and (3) establishing loss parameters for structures using the statistical energy method.

Electronics and Automation Research and Technology

W82-70196 **506-54-15**
Jet Propulsion Laboratory, Pasadena, Calif.
AUTOMATED DECISION-MAKING/MACHINE INTELLIGENCE
Leonard Friedman 213-354-3888

The general objective of this task is to develop software tools that automate NASA mission operations functions which are now labor intensive. Functions being investigated are: (1) automatic generation of computer code by planning methods (command sequence generation); (2) scheduling of spacecraft events (time-lining), (3) fault diagnosis of spacecraft. A second general objective is to assist and guide workers engaged in the uplink process control tasks of mission operations. Help will be provided to generate appropriate knowledge bases that work with the software tools and produce the desired solutions. Interaction between the research and application efforts is expected to reveal shortcomings of the initial implementations and thus permit an evolutionary approach to a usable and practical working system. A specific objective for FY-82 is to produce a demonstration of a planner that will generate code for realistic mission command sequences. This will be a frozen version of the research software that will be a usable product for a selected ongoing mission. A second specific objective is to implement a scheduler that will interact with the planner. A third is to continue the development of fault diagnosis, extending it to more realistic problems. The approach is to construct theoretical models of the logic employed for each of the functions and then to implement the models on a computer. Such techniques are general-purpose methods drawn from the discipline of artificial intelligence, and offer the possibility of widespread application in other areas. In addition, expert users will be working with the research implementations to expose difficulties in a realistic way.

W82-70197 **506-54-16**
Goddard Space Flight Center, Greenbelt, Md.
MACHINE INTELLIGENCE
Rodger A. Cliff 301-344-6849

The general objective of this RTOP is to expand the application of automation in the space program. The intention is to provide NASA with the basic technology required for knowledge based systems. The approach of this RTOP is to perform basic research in machine intelligence (primarily at Universities) and to perform development work on machine intelligence in a NASA context (primarily in-house). Central to this approach is the initiation of a continuing relationship with an established research group in machine intelligence at a major university and the establishment of an in-house development group in machine intelligence.

W82-70198 **506-54-23**
Langley Research Center, Hampton, Va.
INTELLIGENT SYSTEMS RESEARCH
A. J. Meintel 804-827-2489
(506-54-13)

The research objective is to advance intelligent systems technology to enable the design, development, and utilization of advanced teleoperator and robotic devices to enhance man's capabilities for future space activities including structural assembly, servicing, maintenance and repair, and space manufacturing. The program focus will be to conceptualize, investigate, and verify algorithms, sensors, actuators, software, and system architecture required for automated space operations. Specific near term objectives are: (1) develop an in-house laboratory to provide a basic capability to experiment with and explore teleoperator and robotics concepts; (2) develop an interactive real time computer simulation of teleoperator and robotic systems for the development of algorithms and concepts for the use of such systems in space; and (3) development of multiple arm coordination techniques and software.

W82-70199 **506-54-25**
Jet Propulsion Laboratory, Pasadena, Calif.
MACHINE VISION AND TELEOPERATOR ROBOTS
C. F. Ruoff 213-354-6101

The overall objective of this RTOP is to develop and demonstrate sensing, perception, and control technology needed for automated space systems, teleoperators, and robots. Specific objectives include: (1) the development and laboratory demonstration by 1986 of a control oriented computer vision system which is capable of target body tracking over a noisy background and (2) the development and demonstration of a supervisory control system with telepresence for remotely operated teleoperator robots in 1986. Supporting objectives in 1982 include: (1) developing and testing extensible visual models for three dimensional objects; (2) extending stereo recognition algorithms; (3) increasing the speed of tracking algorithms; (4) performing initial tracking experiments in noisy scenes; and (5) determining realistic design goals and generating a development plan for a supervisory control system with telepresence. The approach to computer vision will focus in the near term on algorithmic as opposed to hardware development. Robust approaches which can tolerate variability will be sought with attention being paid to their eventual implementation in parallel hardware processing networks. Supervisory control efforts will focus this year upon an analysis of realistic future teleoperator robot requirements as contrasted with available technology. From this work a technology development plan can be formulated which will be used to guide subsequent Research and Development activities. These Research and Development activities will use the facilities and capabilities of the JPL Teleoperator and Robotics laboratories.

W82-70200 **506-54-33**
Langley Research Center, Hampton, Va.
COMPUTER SCIENCE RESEARCH PROGRAM PLANNING
Susan J. Voigt 804-827-2083
(506-61-13)

The application of digital computer technology to NASA programs and missions and related research in computer science has generally been ad hoc and uncoordinated. A program plan with long range objectives for specific research in computer science and coordinated infusion of computer technology into the center will be developed. Local workshops will be held to review existing areas of computer science research at LaRC, to identify new areas of research particularly relevant to LaRC programs and NASA needs, and to develop an overall plan for research in specific areas of computer science for FY 83 and beyond.

W82-70201 **506-54-35**
Jet Propulsion Laboratory, Pasadena, Calif.
COMPUTER AND SYSTEMS SCIENCES
E. Heer 213-354-3060
(506-61-15; 506-61-05)

The general objective is to assess the needs and potential methods for system and computer sciences of value to the applications of automation and autonomous systems to NASA missions and operations, to develop a comprehensive plan for developing the required technologies to support the applications of automation and autonomous systems to NASA missions, and to implement this plan. The implementation of this plan will provide the basic computer and system sciences technology required to materially expand the capability of NASA missions, and to increase the productivity and effectiveness of NASA as a government agency. The enhanced technology will increase human productivity and improve system performance, reliability, and predictability. These objectives will be achieved by developing techniques to improve access to the information describing the missions and systems during their life cycles, and by developing an integrated set of systems development and software development methods and tools that are used in the planning, design, and implementation of such missions. The objectives for FY-82 are to: (1) contribute to the development of a NASA computer and system sciences plan by an interdisciplinary committee from NASA centers, industry, and selected universities; (2) extend the FY-81 work in assessing software engineering and systems methodology to cover a broader range of computer and systems science issues of importance to automated operations and autonomous systems; and (3) prepare a long range (10 years) JPL plan for a major initiative in computer and systems sciences which will provide for the development and transfer of technology needed to meet NASA's particular requirements.

W82-70202 **506-54-36**
Goddard Space Flight Center, Greenbelt, Md.
COMPUTER AND SYSTEMS SCIENCES
Paul B. Schneck 301-344-9690

This RTOP will focus on issues, problems, and opportunities which will form the basis of a program plan for computer science for FY-83 and beyond. The approach will be to identify the NASA human resource status and work with both the academic and industrial communities to generate a plan sensitive to areas which will receive attention without (additional) NASA funding and those which will be significantly influenced by (additional) NASA funding. A plan will be generated indicating (in priority order) program areas for a computer science thrust which will be of most direct benefit to the agency. Because resources are expected to be limited, two lists must be produced; one for near term activities, and one for long term activities.

W82-70203 **506-54-41**
Ames Research Center, Moffett Field, Calif.
PHOTOPHYSICS AND LASER DIAGNOSTICS
R. L. McKenzie 415-965-6158
(506-51-11)

The general objective is to incorporate modern laser technology and photophysics in a program to develop nonintrusive techniques for the characterization of gaseous media in a dynamic state. In most cases, the gas will be flowing and may also be dynamically unsteady and thermally or chemically out of equilibrium. Primary emphasis continues to be placed on the measurement of turbulent fluctuations in the state variables of cold transonic and supersonic wind tunnel flows. A secondary activity involves the spectroscopy of small molecules important in the photodiagnostics of cold air flows and combustion processes.

W82-70204 **506-54-42**
Lewis Research Center, Cleveland, Ohio.
QUANTUM ELECTRONICS: ELECTROPHYSICS
R. E. Alexovich 216-433-4000
(506-61-22; 541-02-12; 650-60-22)

The objective of this RTOP is to develop technology, concepts, and components for improving life, reliability, and performance of microwave electron beam amplifiers. To pursue this objective, research and technology development programs will be undertaken on various components of microwave amplifiers such as high current density thermionic and field emission type cathodes, beam forming, and confining devices and materials. Futhermore, the studies and development of submillimeter wave, tunable backward wave oscillators as milliwatt level local oscillators for molecular spectroscopy will be established.

W82-70205 **506-54-43**
Langley Research Center, Hampton, Va.
QUANTUM ELECTRONICS: DEVICES AND SENSORS
S. L. Ocheltree 804-827-2179
(506-61-73)

The broad objective of this research is to discover, investigate, and develop novel electro-optic materials, devices, and sensors involving laser electro-optic modulators. Initial emphasis will be placed on improving sources of coherent radiation needed in the 9 to 12 micrometer region for remote sensing of the Earth and planetary atmospheres, and faint astronomical sources.

W82-70206 **506-54-45**
Jet Propulsion Laboratory, Pasadena, Calif.
QUANTUM ELECTRONICS
D. Hinkey 213-354-3555

The objectives of the Quantum Electronics task are to perform basic research into the interaction of electromagnetic radiation with matter, to develop new lasers for remote sensing applications, and to perform fundamental measurements to demonstrate remote sensing potential. The following subtasks are in support of these objectives: (1) compact submillimeter laser subtask to show feasibility of a small, frequency agile submillimeter laser for spectroscopy and remote sensing; (2) diffraction radiation generator subtask to show feasibility of a diffraction radiation generator coherent source operating at submillimeter wavelengths; (3) molecular ion laser subtask to show feasibility of electric discharge pumped molecular ion lasers for active remote sensing applications; (4) raman down conversion in dissociated metal halide vapor subtask to demonstrate efficient UV-to-visible down conversion via stimulated Raman scattering; (5) physics of molecul. interactions subtask to study physical and chemical interactions of electromagnetic radiation, ions, electrons, and metastables with molecules to support development of UV/ visible laser sources for remote sensing; (6) IR and far-IR laser research which will use tunable SLM CO2 TEA laser to study the pumping of molecular transitions to generate other IR/FIR wavelengths; (7) electron impact spectroscopy sub task to measure cross sections for electron-atom and electron-molecule interactions pertinent to laser and plasma devices; and (8) electron impact emission visible and UV processes subtask which measures optical emission cross sections and oscillator strengths for fluorescence generated by electron impact on atoms and molecules of interest.

W82-70207 **506-54-46**
Goddard Space Flight Center, Greenbelt, Md.
QUANTUM ELECTRONICS : SUBMILLIMETER WAVE TECHNOLOGY
H. W. Price 301-344-7101
(506-61-36; 506-18-16; 506-54-56)

The first task concerns long wavelength heterodyne components. Its objective is to develop components for infrared heterodyne spectrometers for use in the study of electromagnetic radiation from remote sources at wavelengths greater than 15 micrometers. An infrared photomixer, IF preamplifier and a diode laser local oscillator will be developed. The second task concerns efficient and tunable submillimeter wave local oscillators; the objectives of this task are as follows: (1) to improve the efficiency and power output of existing lasers using energy transfer and buffer gas techniques; (2) to produce new SMMW lasers and pump lasers, (including tunable solid state lasers); (3) to tune the present laser emissions using intracavity phonon scattering in quartz; and (4) to evaluate the use of nonlinear up-conversion of broadband radiation in the 10 micrometer region using AgGaS2.

W82-70208 **506-54-51**
Ames Research Center, Moffett Field, Calif.
NONLINEAR INFRARED FIBER OPTICS
J. H. Goebel 415-965-6525

The objective of this RTOP is to develop and evaluate nonlinear fiber optics for advanced sensors, detectors, and processors to enable new space experiments, better sensing, and higher information and data transfer for space applications using integrated optical techniques. Activities will include: (1) the demonstration of frequency doubling in the 5 micrometers regions; and (2) the summing of 5 micrometers radiation into the visible for ultra sensitive high bandwidth detection of infrared photons. The introduction of nonlinear fibers will extend the nonlinear optical techniques to longer infrared wavelengths than currently are accessible with low power lasers. All work performed under this RTOP will be closely coordinated with related NASA activities.

W82-70209 **506-54-53**
Langley Research Center, Hampton, Va.
INTEGRATED OPTIC SIGNAL PROCESSOR
R. L. Stermer 804-827-3535
(506-54-63)

The objective of this research is to develop advanced signal processor architectural concepts which take advantage of integrated optic technology and to integrate these concepts in III-V semiconductor and related materials. A balanced approach of in-house and contractual research is to be initiated. Architectural concepts of integrated optics signal processors are to be investigated to determine optimum organizations and device structures to meet future spacecraft information systems requirements. These studies will be balanced with developmental efforts leading to the integration of specific optical/electro-optical circuits in III-V semiconductor materials.

W82-70210 **506-54-55**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA TRANSMISSION AND PROCESSING RESEARCH
A. R. Johnston 213-354-4054

The overall objective of this RTOP is to advance the techniques and the technology of devices critical to fiber optic data transmission and real time data processing for future NASA mission applications. The first task concerns wideband fiber optic data transmission. The specific FY-82 objectives are to develop the components of a wideband fiber optic data link with multigigabit/sec transmission rate and to apply the device technology to applications such as optical metrology, DSN time, or phase transmission and computer networking. The approach of this task consists of the development of a stable and solid state picosecond laser pulse generator, the investigation of ultrafast detection techniques, and the evaluation of integrated optic and fiber optic data switching and processing devices. The results of this task will lead to the capability of gigahertz switching of picosecond optical pulses for fiber optic pulse coded data transmission, the detection of picosecond optical pulses, and the demonstration of millimeter resolution laser ranging technique using such pulses. The second task concerns advanced optical techniques for real time data processing. The goal is to develop real time processing systems using optical and electro-optical elements. Emphasis will be placed on low power, light weight systems for onboard processing of remote sensor systems. The FY82 objective is to perform laboratory evaluation of real time data processors for synthetic aperture radar system. It is hoped that the research funded by this RTOP will lead to a real time onboard system such as an aircraft or spacecraft borne SAR data processor with at least TV type resolution (i.e., about 500 to 1000 elements across the swath).

W82-70211 **506-54-56**
Goddard Space Flight Center, Greenbelt, Md.
SIGNAL DETECTION AND PROCESSING
G. Chin 301-344-5333

The broad objectives of this program are to develop detection techniques for spectral line observations which can span the spectrum from millimeter, submillimeter, to intermediate infrared ranges. This goal will be accomplished by: (1) developing SIS (superconductor-insulator-superconductor) tunnel junction mixers as detectors in millimeter and submillimeter heterodyne receivers, A.R. Kerr/ Code 103; (2) developing compact, lower-power, and wide bandwidth RF spectrometers for use in tandem with millimeter, submillimeter, and infrared heterodyne receivers using bulk Bragg cell and integrated optics Acousto-Optic Spectrometers (AOS), G. Chin/ Code 693.1; and (3) developing tunable cryogenic Fabry-Perot filters with high resolving power and wide tunability in the intermediate infrared range, J.F. Arens/ Code 693.2. An additional task concerns multispectral ultrasensitive detectors. The objective of this task is to develop advanced instruments and

telescopes for use with Shuttle flights and new missions dedicated to observation and astronomical studies from space as well as on the ground. This will be accomplished through the advancement of detector technoloy to obtain high resolution, low noise, large format imaging systems for use in spectral ranges extending from soft X-ray through the ultraviolet and visible into the far red.

W82-70212 **506-54-59**
Marshall Space Flight Center, Huntsville, Ala.
SIGNAL DETECTION AND PROCESSING: HIGH DENSITY CIRCUIT TECHNOLOGY
J. M. Gould 205-453-3772

The objective is to assure the means for implementing quick turn-around prototype chips for breadboarding plus space qualified custom chips for flight at a cost which enables a wide breadth of applications. It is predicted on an extreme degree of sameness to make effective chip qualification affordable. A standard electronically reconfigurable logic array is provided which permits, in effect, the rewiring of digital logic from the ground while the logic is in flight. It enables adaptive control and signal for breadboarding. Lastly, integrated optical design techniques and fabrication are provided.

W82-70213 **506-54-60**
National Aeronautics and Space Administration, Washington, D.C.
ELECTRONIC DEVICES
Martin M. Sokoloski 202-755-3273

The objective of this program is to provide effective coordination of NASA-sponsored research and development efforts on electronic devices and systems with similar work supported by DOD and other government agencies. Through associate membership on the Advisory Group on Electron Devices and its constituent working groups, NASA program managers receive expert advice on the feasibility, currency and soundness of planned R&D procurement activities, long ranging R&D requirements, complementary work in other government agencies, and forecasts of new technical developments.

W82-70214 **506-54-63**
Langley Research Center, Hampton, Va.
SOLID STATE RESEARCH
R. L. Stermer 804-827-3535

The objective is to develop advanced electronic devices and components which increase the capability of processing and distributing information in aerospace systems. This increased capability of information handling is to be accomplished with corresponding increases in cost efficiency. Additional, new device concepts and fabrication techniques which enhance information acquisition in terrestrial observation and similar aerospace applications are to be evaluated. A balanced approach to obtain the advantages of in-house research, grants, and research contracts is to be used. Theoretical and experimental investigations of device concepts, materials, and processing techniques will be conducted in-house. Contractual efforts will be used to develop the device concepts and technologies to a level of practical demonstration. This complementary effort of in-house and contractual research is to be supplemented with university research to provide the scientific base to predict device performance over a wide range of applications.

W82-70215 **506-54-65**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTAL ELECTRONICS
Joseph Maserjian 213-354-3801
(506-18-35; 677-27-10; 506-20-65)

This RTOP consists of two major tasks. A task concerning the physics and chemistry of reliability has, as its objective, research and development of methods for overcoming major reliability problems which limit the implementation of advanced semiconductor technology, such as large and very large scale integrated (LSI and VLSI) circuits and large area monolithic detector arrays necessary for future space systems. The problems, are lack of long life reliability, fundamental material defects, susceptibility to radiation damage, and lack of custom design and testing capability. The approach is aimed primarily at the physics and chemistry of semiconductor interfaces, the regions most critical to device performance and reliability. Advanced electrical and interface/surface analytical techniques are developed to study various phenomena, such as correlations between chemical processing and device degradation. Results are being applied in collaboration with industry on problems such as radiation hardening, and are used as a base for diagnostics to be applied on test chips for product assurance of LSI. Custom LSI capabilities are being addressed by the development of computer aided design tools for NASA wide use. A second task concerning advanced solid state devices has as its objective the development of advanced devices such as solid state oscillators, multispectral sensors, detectors and mixers, and superconducting devices for future space mission requirements. The approach is based on investigations of new materials, techniques, and device structures, e.g., the synthesis of new semiconductor microstructures by means of advanced ultrahigh vacuum techniques such as molecular beam epitaxy with associated surface analysis techniques. Current efforts will impact advanced monolithic IR detector arrays for Earth observation missions, submillimeter wave devices for atmospheric spectroscopy, cryogenic semiconductor bolometers for improved far IR space telescope detectors, and improved pyroelectric IR detectors for long term noncryogenic operation.

W82-70216 **506-54-69**
Marshall Space Flight Center, Huntsville, Ala.
SOLID STATE RESEARCH; SUPERCONDUCTING CIRCUITRY
P. N. Peters 205-453-5134
(188-41-54; 676-59-33)

Existing facilities for thin film deposition, microfabrication, and cryogenic measurements are being utilized to investigate and develop sensors based on superconducting electronic properties. These devices will be compatible with cryogenically cooled flight experiments, such as the Gravity Probe-B, the Gravity Gradiometer, etc. Single and arrayed Josephson junctions, superconducting-insulator-superconducting (SIS) devices, coupling techniques, fundamental material properties, superconducting quantum interference devices (SQUID's), and sensor/photon interactions are being investigated.

W82-70217 **506-54-73**
Langley Research Center, Hampton, Va.
ADVANCED SPACECRAFT POINTING AND CONTROL SYSTEMS
J. D. Shaughnessy 804-827-3917

The research will study and compare several techniques for design of effective control systems for large space structures, including decoupled control design, linear-quadratic-Gaussian (LQG) design, and multiobjective-insensitive design. Real-time adaptive/learning and self-reorganizing control algorithms for large space structures will be developed. The adaptive/learning algorithms will have the capability to affect on-line modification of a control system based on on-orbit testing. The self-reorganizing system will affect on-orbit redesign of a control system accounting for the failure state of the system. The effectiveness of the various design techniques will be compared considering problems of particular importance in controlling large space structures, such as the requirement to use a reduced order model, the effects of distributed control actuators and sensors with realistic dynamic response characteristics, and uncertainties and variations in the system model. Control configurations designed by these methods will be tested in the Langley experimental beam facility. Adaptive/learning and self-reorganizing algorithms developed will also be tested in the experimental apparatus. More complex experimental structures will be designed and constructed for future testing.

W82-70218 **506-54-75**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACECRAFT POINTING AND CONTROL
A. F. Tolivar 213-354-6215
(506-62-45; 506-54-85)

This RTOP embraces three mutually complementary tasks

for the development of advanced spacecraft pointing and control analysis and system concepts required by a wide range of future missions including flexible large space structures and planetary spacecraft. The first task involves the development of fundamental analysis and design technology for control of distributed systems. The long range goal of this task is to provide a technology base in distributed control design that will support flexible spacecraft trade studies in the mid-1980's and detailed analysis and design for optimal systems in the 1990's. The FY-82 objective is to expand prior developments in the area of control for single body systems described by simplified continuum models to interconnected flexible multibody systems that more appropriately characterize real spacecraft configurations. The second activity provides for continued development of model error estimation technology for autonomous detection of inevitable model errors. The long range objective is to improve on the foundation for adaptive control capable of compensating for spacecraft model deficiencies. Prior work has defined methods for model error estimation and evaluation of estimator performance with relatively low order spacecraft models. In FY-82, the objective will be to extend this capability to spacecraft with large numbers of degrees of freedom (more than 20) and to evaluate the performance of the estimator designs. The third task will initiate the development of new advanced system concepts aimed at low cost multiple mission planetary spacecraft control technology. FY-82 objectives are to examine the mission models and define levels of commonality, implementation requirements, and optimum system boundaries required to support low cost automated missions.

W82-70219 **506-54-85**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED GUIDANCE AND CONTROL COMPONENTS
A. F. Tolivar 213-354-6215

The long range objective of this RTOP is to develop, and verify innovative guidance and control component technology for spacecraft control systems with emphasis on low cost, and reduced weight and power for future planetary space vehicles and large space systems. The FY-82 RTOP tasks involve the continuing development of the Fiber Optics Rotation Sensor (FORS), Optical Measurement Technology (OMT), and the initiation of development of a Spatial High-Accuracy Position-Encoding Sensor (SHAPES). The FY-83 and 84 tasks will include FORS, SHAPES, and WALLASS a low-cost sun sensor for outer-planet missions. The objective of the FORS task is to develop a light-weight, low cost, inertial reference having an operating life in excess of ten years and random walk error rate of less than .005 deg/square root hr. The approach utilizes newly developed integrated optics elements for optical signal processing, a semiconductor laser, and a multi-kilometer length of low loss fiber-optic waveguide arranged into a rotation-sensitive Sagnac interferometer. The objective of the OMT task is to demonstrate a flight scaled, autonomous optical navigation measurement extraction software package. The approach is to: (1) complete fabrication and calibration of the CCD imager/microprocessor based demonstration system, (2) demonstrate target body centerfinding algorithms applicable to autonomous onboard measurement extraction in laboratory and field tests, and (3) demonstrate data compression suitable for flight use. The objective of the SHAPES task is to develop a control sensor for determination of the static shape and vibrational motion of large space structures as well as for the rendezvous and docking of all classes of spacecraft. SHAPES will combine electro-optical techniques to measure the three dimensional coordinates of many points distributed over the structure surface at reading rates high compared to the structure frequencies. The objective of the WALLASS is to develop a low-cost Sun sensor for outer-planet missions.

Space Power and Electric Propulsion Research and Technology

W82-70220 **506-55-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED ENERGETICS
Robert W. Bercaw 216-433-4000

The objective of this effort is to investigate advanced concepts in energy processing for space applications. The energy processing elements include the areas of (1) sources, (2) conversion techniques and devices, (3) storage, and (4) transmission or distribution systems and components. Concepts to be investigated in this program are those considered to be high risk and innovative; but, if successfully developed, could provide substantial performance improvements for space missions beyond the 1990's. Advanced energetics concepts will be identified by literature search and communication with leading researchers. In addition, an annual solicitation will be made to search out new promising concepts. The concepts will be assessed by in-house and contracted studies and analysis. Experiments and theoretical efforts will be conducted on key technologies to investigate concept feasibility.

W82-70221 **506-55-13**
Langley Research Center, Hampton, Va.
ADVANCED RADIANT ENERGY CONVERSION
E. J. Conway 804-827-3781

The objective is to conduct basic research on and to evaluate advanced concepts for the generation, transmission, and conversion of energy in space. Research is performed to characterize radiation-induced plasmas leading to efficient high-power conversion of concentrated solar energy directly into electromagnetic radiation, laser power, or work. Radiation-induced plasmas are studied to determine population inversion, nonequilibrium emission, and ionization and excitation cross sections. The possibility of new lasers in the ultraviolet and visible region with greatly increased power output is studied. Studies for the selection of the most promising lasing media and transitions are performed for direct solar excitation. Intense broadband UV and visible photon sources in operation and under development at LaRC are used to experimentally investigate broadband-pumped chemically reversible lasers and plasma heating. Efficient methods of converting monochromatic and broadband photon energy directly to electricity are investigated. Reverse free electron laser, optical frequency rectifier, and MHD concepts are assessed in terms of feasibility and potential payoff for in-space power conversion. An additional broad objective is examination of present and anticipated technology and the conceptual design of a solar-powered electric-propelled airborne spacecraft. The RTOP has sufficient flexibility to take advantage of unique opportunities and concepts to advance space energetics research.

W82-70222 **506-55-15**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED ENERGY TECHNOLOGY
Jones R. M. 213-354-6674
(506-55-12; 506-55-13; 506-55-19)

The objective of this RTOP is to identify, evaluate, and if justified, recommend for additional OAST funding, innovative advanced concepts in the areas of energy collection, conversion, transmission, and storage which show promise to enable or significantly enhance future space power systems. New and existing concepts will be evaluated. This evaluation will systematically address the basic feasibility of the concept, problem areas, and potential value when developed. This work is necessary to provide the fundamental understanding required to advance our capability to explore and use the extraterrestrial environment. The highest ranking concepts will be subject to a more detailed evaluation. This evaluation will include preliminary systems studies, analytical modeling, and/or testing of experimental hardware. The results of these detailed evaluations will be assessed and concepts of outstanding or potential merit will be recommended to OAST for separate funding. The specific concepts to be investigated in FY-82 are: (1) an alkalai metal thermoelectric converter (AMTEC); (2) a plasma heat pipe; (3) an optical rectifier

for laser energy conversion; (4) polymer films for photoelectrocatalysis; and (5) laser driven MHD.

W82-70223 **506-55-19**
Marshall Space Flight Center, Huntsville, Ala.
LASER PROPULSION
R. J. Richmond 205-453-3710

A combined analytical and experimental program is being pursued which examines the feasibility of the laser propulsion concept and develops the technology required to implement the concept. Laser radiation absorption experiments using pure hydrogen, seeded hydrogen, and other propellant gases will be conducted. Experimental results will be compared to analytical predictions and from this a generalized thruster design model will be developed. Parametric analyses of thrusters using various propellants will be conducted, and finally one configuration will be fabricated and tested.

W82-70224 **506-55-22**
Lewis Research Center, Cleveland, Ohio.
ELECTRIC PROPULSION TECHNOLOGY
David C. Byers 216-433-4000
(506-55-32)

The overall program objective is to identify and develop the technology for future electric propulsion systems for planetary and Earth orbital missions. Electric propulsion system technology will be developed for auxiliary propulsion functions for future geosynchronous spacecraft and large space systems. A mercury primary propulsion technology effort is underway to enable new planetary missions. The advanced primary propulsion technology program will identify and develop the electric propulsion technology to enhance the performance and reduce the cost of Earth orbital missions. The program consists of analyses and experimental efforts. Focused activities will be directed toward characterizing and improving the performance, lifetime, and interfaces of critical system elements such as thrusters and power processors. Supporting technology activities will evaluate phenomena of broad relevance to electric propulsion aproaches.

W82-70225 **506-55-32**
Lewis Research Center, Cleveland, Ohio.
ION THRUSTER RESEARCH AND ION BEAM APPLICATIONS
Thomas H. Cochran 216-433-4000

The objectives of the research to be performed under this RTOP are to understand the physical processes of electric propulsion systems, to investigate advanced ion and other types of propulsion concepts, and to define and evaluate nonpropulsive applications of electric propulsion technology. The activities performed under this RTOP include investigations of concepts to improve the performance, reliability, and durability of ion thrusters. In addition, advanced propulsion concepts will be conceived and investigated for in space and to space propulsion. Non-propulsive applications of ion thruster technology will be evaluated for the development of new or improved materials, processes, and products.

W82-70226 **506-55-35**
Jet Propulsion Laboratory, Pasadena, Calif.
MPD THRUSTER SYSTEM TECHNOLOGY
E. V. Pawlik 213-354-3455

The long term objective of this RTOP is to pursue research into the controlling physical processes involved in electric propulsion, to evaluate advanced concepts such as the magnetoplasmadynamic (MPD) accelerator, and to investigate the non-propulsive applications of electric propulsion technology. The FY-82 objective is to complete the preliminary technology evaluation of the MPD thruster and then embark on technology development if appropriate. Specifically, this effort will establish the fundamental viability of the MPD thruster by demonstrating that the problems limiting performance and lifetime can be resolved. The approach will be to: (1) evaluate the technology associated with operating quasi-steady state MPD thrusters with pulsed energy transfer systems; (2) define the potential efficiency and lifetime of the MPD thruster; (3) conduct a preliminary conceptual study of how a MPD thruster might be incorporated into either solar electric propulsion or a nuclear electric propulsion vehicle; and (4) provide basic understanding of the physical processes involved in MPD thrusters. Specific thruster performance goals for this program include thrust densities over 1000 N/M(2), exhaust velocities between 20 and 100 Km/sec, thrust efficiencies over 50%, and a lifetime commensurate with projected applications, including deep space exploration.

W82-70227 **506-55-42**
Lewis Research Center, Cleveland, Ohio.
SOLAR CELL TECHNOLOGY
H. W. Brandhorst 216-433-4000

The objective of this RTOP is to improve conversion efficiency, reduce mass and cost, and increase the operating life of solar cells and blankets. Research and technology programs cover several diverse areas. Major thrusts include development of limit-efficiency silicon solar cells, understanding and reducing the radiation damage suffered by high efficiency silicon solar cells through basic research and development, and the production of large area low cost silicon cells. Development of ultralightweight GaAs cells less than 10 micrometers thick; radiation tolerant, high efficiency, low cost GaAs cells, and high efficiency, temperature stable GaAs cells for concentrator applications will continue. Cascade solar cells made from III-V materials that have the potential for achieving 30% conversion efficiency will be developed, and concepts that utilize the wave nature of light will be explored. A long range, NASA-wide plan to bring the technology for reliable, durable welded solar cell interconnects will be established and thin, flexible space durable encapsulants will be developed.

W82-70228 **506-55-43**
Langley Research Center, Hampton, Va.
SOLAR CELL RESEARCH
E. J. Conway 804-827-3781

This basic research program is broadly oriented toward developing the technology to improve conversion efficiency, reduce mass, reduce cost, and increase the operating life of GaAlAs/GaAs solar cells. The research and development to achieve high efficiency (18 to 20 percent in space) GaAlAs/GaAs solar cells with high temperature (200 to 300 C) operating capability, low weight, and long life in a radiation environment is being performed for potential space applications, such as high power space manufacturing stations, near Sun exploration, and long life GEO missions. Currently, this program emphasizes thin crystal p-n junction cells for high power-to-weight ratio space cells. Liquid phase and chemical vapor deposition epitaxial growth techniques are employed to develop these improved cells. A second research emphasis involves the effects of proton and electron irradiation on cells and cell materials, optimization of the structure to maximize radiation stability, and annealing to heal radiation damage. The long term stability of cells and contacts at 200 C is studied to support concentrator and continuous annealing modes of operation. New contact materials are systematically studied. In addition, the program generates new cell concepts and techniques through funding and encouragement of universities and industries.

W82-70229 **506-55-45**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY SOLAR ARRAY RESEARCH AND TECHNOLOGY
Walter A. Hasbach 213-354-6132

The primary objective of this RTOP is to develop and demonstrate high performance (> 300 W/kg at 1 AU) array technology suitable for shuttle launched interplanetary and geosynchronous missions. Ultrathin (50 microns) silicon or gallium arsenide solar cell blankets coupled with new array structure concepts such as the graphite-epoxy stacking triangular articulated compact beam (STACBEAM) are projected to result in high power (> 25 kW) arrays rated at > 300 W/kg. A secondary objective is to develop and demonstrate concentrator enhanced arrays which are superior with respect to specific power and cost to present space power systems for missions over the range of 3 to 10 AU. To this end a modified STACBEAM and the multiple flat plate collector (MFPC) array structure will provide

the technology focus. The third objective is to identify appropriate DOE developed cell technology suitable for space power needs. Specific tasks for FY-82 are to: (1) develop an approach to fabricating an ultrathin solar cell blanket ultimately capable of 600 W/kg and able to survive the geosynchronous environment for 10 years; (2) develop low mass array structures compatible with high performance blankets which can ultimately provide 300 W/kg arrays for geosynchronous applications; (3) develop an optimized concentrator enhanced array designed specifically for outbound missions within 4 AU; (4) publish a revised edition of the Solar Cell Radiation HandbooK; (5) draft a second update of an evaluation of DOE developed technology applicable to space power needs; and (6) develop a GaAs cell structure using OM-CVD (chemical vapor deposition) ultimately capable of > 16% AMO, and develop a < 75 microns GaAs/Ge/Si cell structure using OM-CVD capable of providing 14% by FY-83.

W82-70230 **506-55-49**
Marshall Space Flight Center, Huntsville, Ala.
EARTH ORBITAL PHOTOVOLTAIC ENERGY CONVERSION
William L. Crabtree 205-453-2110

The objective of this RTOP is to advance the state of the art in multi-kW solar arrays for earth orbit; it is necessary for support of future NASA missions such as space construction base and public service platform missions. This RTOP will be a combination of in house and contracted efforts and will consist of the following tasks: (1) low cost multi 100 kW solar array concept and technology development; and (2) investigation of theoretical concepts for power generation. Evaluation of thermophotovoltaics and spectrophotovoltaics will be by analytical and experimental means, to assess their capability to provide low cost multi-100 kW power.

W82-70231 **506-55-52**
Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE
Lawrence H. Thaller 216-433-4000

The objective of this program is to obtain long life, high energy density, high reliability and lower cost electrochemical storage and conversion devices. The emphasis is on devices that will be required for future space missions. There is a marked trend towards higher power and higher voltages. This emphasis will be conducted within the framework of multiyear plans which take into account the needs of user groups and the efforts of other NASA Centers as well as the Air Force. During FY-82 the work in the Nickel-Hydrogen area will consist of more firmly establishing the component technology of current cell designs as well as investigating advanced cell design concepts applicable for multi kilowatt systems. The Nickel-Hydrogen Plan delineates the task areas and major milestones for this coordinated effort. The ongoing technology efforts in the alkaline Hydrogen-Oxygen fuel cell and water electrolysis areas will be continued and increased in keeping with the emphasis on combined fuel cell/water electrolyzers for energy storage applications. Efforts will be maintained toward the goal for providing advanced technology fuel cell components for improved orbiter type hardware as well as for spacetug type applications. In addition a multi center, interagency long range plan for advancing fuel cell and water electrolyzer technology to meet perceived missions will be completed under LeRC leadership. Much of the in house R&D efforts related to electrode, separator, and component technologies will support these two major parts of the multi KWh storage effort. The synthetic battery cycling and system assessment efforts will continue to provide guidance and direction for the rest of the program.

W82-70232 **506-55-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED NICKEL-CADMIUM AND LITHIUM BATTERIES
I. Stein 213-354-6048

The overall objective of this RTOP is to achieve improved performance, energy density, and lifetime of space batteries for applications in interplanetary and Earth orbital missions. The effort involves three tasks. One task objective is to achieve a fundamental understanding of failure mechanisms in aerospace Nickel-Cadmium cells by FY-83. The FY-82 principal objective is to identify degradation mechanisms for both chemically and electrochemically deposited Ni-Cd cells. The approach is to correlate results from destruct and nondestruct analyses, and to select, investigate, and correlate known failure modes with the Jet Propulsion Laboratory's failure model. Another task is to develop safe, reliable primary lithium batteries with high energy density (> 300 Whr/Kg) and long life (> 5 yrs) for future NASA missions by FY-85. Major objectives for FY-82 are to identify the cell components and their reactions which limit safe operation and cause loss of capacity during storage. Approach will involve use of electrochemical, chemical, and thermal measurements on components of state-of-the-art Li-SOCl2 and Li-SO2Cl2 cells to identify the causes for the safety problems in life limitations. The objective of the final task is to develop ambient temperature secondary lithium batteries with an energy density of 200-W-hr/Kg and greater than 5 year lifetime by FY-87. Major FY-82 objectives are to evaluate and understand the intrinsic performance capabilities of the Li/LiAsF6-2-MeTHF/TiS2 system and to assess new improved cell component materials. The approach will be the investigations of the chemical and electrochemical stability of cell component materials and of the fundamental processes that govern performance and degradation.

W82-70233 **506-55-57**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL ENERGY STORAGE AND POWER SYSTEMS
Hoyt McBryar 713-483-6128

The objective of this research effort is to advance fuel cell and electrolysis cell technology to maturity and to demonstrate suitability to large orbital energy conversion and storage requirements of high power and long life. A data base will be developed at the cell, small stack, and component level. This will provide the basis for design of the larger development test articles. An interim test will be conducted on breadboard-type hardware of about 5 to 7 kW in the integrated mode to verify concept feasibility. This will also serve as a test bed to help define technology limitations and to evaluate interaction phenomena of dissimilar fuel cell/electrolysis cell concepts. Engineering model hardware will be fabricated which incorporates all technology advances for field demonstration of technology readiness. The results will provide a basis for selection of the Regenerative Fuel Cell over other potential concepts for large orbital energy storage systems.

W82-70234 **506-55-65**
Jet Propulsion Laboratory, Pasadena, Calif.
THERMAL TO ELECTRIC ENERGY CONVERSION TECHNOLOGY
G. Stapfer 213-354-3922

The overall objective is to develop thermal to electric direct energy conversion technology providing spacecraft power for exploration of the solar system. The characteristics of such a power system are: low weight, low volume, long life, high reliability, flexibility, minimum integration complexity, and low cost. The SP-100 subsystem is the combination of a fast fission reactor-reactor heat pipe with an advanced thermoelectric conversion subsystem suitably modularized for multi-mission applications. The RTOP is divided into SP-100 Conversion Technology, SP-100 Mission Application Technology, and finally a task on RTG Conversion Technology. An integral part of the objectives is to integrate the subsystems into the SP-100 power system. Regarding the SP-100 Conversion Technology the objective is to develop an NEP system by developing advanced and improved state of the art thermoelectric materials for SP-100 power conversion subsystems. The approaches to be used are: (1) capitalize on the enhance the physical properties of materials such as boron-carbide or lanthanum chromium sulfide to develop conversion materials with high efficiency and high power density and elevated operating temperatures; (2) develop improved state of the art thermoelectric materials to advance the current technology base. The applicability of both technology developments will be evaluated to serve as the prime SP-100 conversion technology. The SP-100 Mission Application Technology has as its first objective to broaden mission applications for

the SP-100 system by determining requirements and capabilities for (1) Earth orbit missions; (2) outer and inner planet missions; and (3) new mission concepts which are enabled or enhanced by SP-100 system. The second objective is to determine the more fruitful areas for future technology development by determining the implications of incremental improvements in NEP technology with respect to mission performance. The objective of the RTG conversion technology task is to develop new and advanced thermoelectric materials for radioisotope heat sources. Promising materials will be examined and optimally doped to provide a more efficient and higher power density conversion subsystem.

W82-70235 **506-55-70**
National Aeronautics and Space Administration, Washington, D.C.
SPACE POWER AND ELECTRIC PROPULSION PROGRAM SUPPORT
J. P. Mullin 202-755-3278

The objective of this RTOP is to help provide overall guidance and information for coordination management and planning of the space power effort. This RTOP will provide for NASA's share of operating the Power Information Center (PIC) of the Interagency Advanced Power Group (IAPG). Fundamental research supporting space power and electric propulsion through universities will be conducted.

W82-70236 **506-55-72**
Lewis Research Center, Cleveland, Ohio.
POWER SYSTEMS MANAGEMENT AND DISTRIBUTION
R. C. Finke 216-433-4000

The objective is to provide the technology base necessary to control the generation and distribution of energy in future space systems and to assure their environmental compatibility. The proposed work will define and develop the generic technology to enable large multi-kilowatt power systems in space. In house and contractual studies will be conducted, as needed, to determine performance requirements, system constraints, and new technology needs for future space power systems. Contract, grant, and in house experimental and analytical programs will be conducted to explore the basic physics of conductors, semiconductors, dielectrics, and magnetic and thermal materials for power devices; develop an analytical model of their operating principles; and develop working prototypical devices, demonstrating them and characterizing performance in typical circuits as required. In addition, this program will perform ground tests to simulate and determine the impact of the environments on spacecraft systems, develop models of the physical phenomena and define space tests to verify ground test data.

W82-70237 **506-55-75**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY POWER SYSTEMS RESEARCH AND TECHNOLOGY
E. V. Pawlik 213-354-3455
(506-55-72; 506-55-77)

The general objective of this RTOP is to develop the technology for controlling spacecraft power system interactions with the charged particle environment of space. This activity is a portion of a joint AF/NASA comprehensive research and technology program on spacecraft environment interactions. This technology will be required to provide design information for both large spacecraft missions and high power modules. Specific objectives in FY82 will be: (1) the completion of modeling of the planetary environments of Jupiter and Saturn and; (2) completion of a study of charge exchange plasma flow around obstructions. The approach for FY82 is divided into five tasks as follows: (1) a study of the sheaths developed around pinholes in high voltage solar arrays using an emissive probe; (2) investigations into the contributions of outgassed molecules to the spacecraft sheath; (3) the development of methods to reduce the effects of ion thruster charge exchange plasma that flows towards the spacecraft; (4) the construction of models to describe the plasma environments of Jupiter and Saturn; and (5) the characterization of both radio frequency and conducted signals from arc discharges.

W82-70238 **506-55-77**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT FOR ON-ORBIT ENERGY SYSTEMS
J. G. Rankin 713-483-4941
(506-62-67; 506-55-77)

The objective of this RTOP effort is to: (1) develop the technology necessary for thermal management of a large space power or operation system; (2) extend orbital lifetime capability of thermal management systems from months to several years; (3) provide the technology necessary for high energy density heat collection and transport; and (4) reduce the cost of very large scale heat rejection systems by orders of magnitude. This will be achieved by the design, development, fabrication, and test of prototype hardware comprising a representative portion of a full scale system. Such a system might consist of an osmotic heat pipe providing a constant temperature 'thermal bus' or energy transport loop that would deliver or receive heat to/from the various subsystems and payload heat sinks or sources via one or more types of modular (i.e., easily connectable/removable) thermal interface devices (contact heat exchangers, fluid or heat pipe quick disconnects, etc.). The primary heat sink for such a system could be made up of relatively simple independent radiator elements containing large, high capacity heat pipes that would provide a space constructable radiator system with long life due to low system vulnerability to the micrometeoroid environment.

W82-70239 **506-55-79**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-100 KW LOW COST EARTH ORBITAL SYSTEMS
J. R. Graves 205-453-2514
(506-55-72)

The objectives of this RTOP are to provide the technology required to process, distribute, and control electrical power in multi-100 kW type platform systems and to reduce space energy costs through improved efficiency, life, reliability, and maintainability. These objectives will be accomplished via a combination of in-house and contracted efforts and will consist of the following tasks: (1) develop the necessary power processing, conditioning, and distribution techniques for high voltage, multi-100 kW power systems; (2) develop utility type power management and control for space power systems; and (3) construct a system breadboard for evaluation and demonstration of new technologies and power management techniques.

Multidisciplinary Research

W82-70240 **506-56-11**
Ames Research Center, Moffett Field, Calif.
FUNDS FOR INDEPENDENT RESEARCH (SPACE)
M. D. Ardema 415-965-5113
(505-36-11)

The objective of this RTOP is to support innovative and discretionary basic research in areas related to space. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical fields of lasers, energetics, materials, applied mathematics, superconductivity, chemistry, and physics. The OAST Research Council and the Ames Basic Research Council review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and the ABRC to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W82-70241 **506-56-12**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (SPACE)
Marvin E. Goldstein 216-433-4000

The objective is to support innovative, long range, high risk, basic research in areas related to space. The program pursues

basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical fields of propulsion, energetics and solar energy conversion, materials and structures, applied mathematics, chemistry, and physics.

W82-70242 **506-56-13**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (SPACE)
Frank Hohl 804-827-2664

The objective of this plan is to support basic research programs in universities in areas related to space through the funding of a limited number of unsolicited research proposals. University research proposals that were evaluated and are not funded through any of the research programs are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be well worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA space programs.

W82-70243 **506-56-19**
Marshall Space Flight Center, Huntsville, Ala.
FUND FOR INDEPENDENT RESEARCH
R. Decher 205-453-5130

The objective of this RTOP is basic research related to NASA's goals of space flight and space science. Work performed under this RTOP includes experimental and theoretical studies of more fundamental problems and of new ideas and concepts connected with scientific flight experiments, advanced scientific instrumentation, and technology.

W82-70244 **506-56-35**
Jet Propulsion Laboratory, Pasadena, Calif.
THEORETICAL MATHEMATICS
F. B. Estabrook 213-354-3247
(506-54-45)

A program of coordinated basic research by mathematicians and theoretical physicists both in universities and at the Jet Propulsion Laboratory will be conducted, with the objective of developing significant new analytical tools for the treatment and understanding of: (1) non-linear phenomena, (2) many-body and collective phenomena, and (3) chaotic and turbulent phenomena. The approach will be to develop theoretical mathematics and related conceptional techniques appropriate to the three areas of interest: (1) Cartan theory of partial differential equations, differential geometry and fiber bundles, soliton theory, Lie groups and algebras; (2) functional integration and renormalization groups; and (3) Hamiltonian systems, mapping theory, homotopy theory and algebraic geometry, and multivariate probability theory. The in-house research effort at JPL will be concentrated in the first two areas of application. A new mathematical approach to the analysis of solitons ad nonlinear waves, using Cartan theory and differential geometry was previously initiated and developed. This breakthrough will continue to be developed and will be applied to selected problems such as one-dimenional soliton conduction in organic lattices, general relativistic gravitation, the transport and interaction of electrons and holes in semiconductor devices. Proposals for mathematical research relevant to the above three areas will be entertained from appropriate university groups. Selection of perhaps 6 to 8 will be made on the basis of originality, importance, and demonstrated research accomplishments. The university contract program will approximately balance the in-house effort at JPL.

Information Systems Research and Technology

W82-70245 **506-61-00**
National Aeronautics and Space Administration, Washington, D.C.
ARCHIVAL MASS MEMORY
C. F. Fuechsel 202-755-2413
(506-61-09)

The objective is to develop an on-line archival mass memory device capable of storing and retrieving up to 10 to the 13th power bits of information at rates up to 50M bits/second. Laser optical disk technology will be employed in concert with a mechanical manipulator to retrieve and mount individual disks. This task replaces the archival mass memory portion of FY-81 RTOP 506-61-59. The optical disk device developed under this RTOP will be full interfaced and operational with the data base management system which is in progress under 506-61-09.

W82-70246 **506-61-03**
Langley Research Center, Hampton, Va.
NASA END-TO-END DATA SYSTEM: INFORMATION ADAPTIVE SYSTEM AND ONBOARD DATA STORAGE
Roger A. Breckenridge 804-827-3535
(506-61-33; 506-54-63)

The primary objective of the Information Adaptive System (IAS) activity is to develop and demonstrate an onboard spacecraft data system which adaptively controls and processes high speed, multispectral sensor data. The IAS will interface directly with Earth resources sensors to provide onboard data control, data formatting, radiometric correction, distortion coefficient determination, data editing, and high speed data packetization. The key hardware and software components required to implement a ground demonstration of the IAS will be developed and a laboratory brassboard of the IAS will be demonstrated and evaluated in a simulated real time data environment. The main thrust of the onboard data storage activity is the development and demonstration of highly-reliable, advanced magnetic bubble memory device and system prototypes to satisfy projected data storage requirements for Earth observation spacecraft. This activity is composed of two elements: ion implanted, magnetic bubble memory development and current accessed, self structured bubble memory development.

W82-70247 **506-61-05**
Jet Propulsion Laboratory, Pasadena, Calif.
NASA END-TO-END DATA SYSTEM
D. E. Erickson 213-354-4066
(323-50-29; 506-54-35; 506-61-15; 506-61-25; 656-29-01)

The objectives of this effort are to define system configurations and to develop enabling techniques and technologies which will significantly improve the effectiveness and efficiency of the NASA-wide information system for the 1980s. The principal emphasis of this effort will be directed towards identifying and resolving end-to-end data system problems related to the deep space missions. The approach being taken includes performing a number of related tasks addressing key elements of the end-to-end system. Each of these tasks will be carried out so as to support and contribute to the activities of the established teams within the overall NEEDS program by representing the interests of the deep space community. Cooperative participation and continuing technical exchanges with other NASA Centers is expected to aid in identifying common (NASA-wide) approaches toward a more effective and efficient end-to-end data system. Major categories of tasks include: (1) Systems: systems engineering and methodology development; (2) Modular Data Transport System (MDTS): spacecraft data systems, channel coding, and packet telemetry evaluation; (3) Data Base Management System (DBMS): DBMS systems/technology studies and the prototype implementation of elements of a deep space DBMS; (4) Information Adaptive System (IAS): optical navigation information adaptive system; (5) Automation: automation of the command and control function and automated ground transport of telemetry. Individual demonstrations and/or reports are

scheduled to aid in the technology transfer process of the NEEDS efforts into flight project activities.

W82-70248 **506-61-06**
Goddard Space Flight Center, Greenbelt, Md.
NASA END-TO-END DATA SYSTEM (NEEDS): PHASE 2
R. W. Nelson 301-344-7809

The program objective is to develop and demonstrate the systems technology and techniques which can enable more efficient and effective transfer of useful data from the sensor to the user, extraction of information by the user, and exchange of information between users. The approach will be to conduct a continuing systems analysis to guide and evaluate the program, to develop new subsystems and operations concepts, and to implement and test demonstrate prototype elements of the end-to-end system. Program elements will enable data processing at the source, enable data autonomy, provide standard data transport formats, enable high speed ground processing, provide rapid user access to data, and analyze command and control systems. Conduct continuing systems analysis and program coordination, develop alternative space platform data system concepts, develop high-speed spacecraft data handling system architecture, develop onboard orbit computation breadboard, develop onboard attitude determination breadboard, demonstrate end-to-end data system modular data transport, develop and evaluate advanced memory technologies for spacecraft data buffering requirements, perform communication coding study for the Tracking and Data Relay Satellite System (TDRSS), design and develop packet management system, develop and evaluate data base management techniqes and technology, integrate and test parallel processing technology, and perform command and control systems analysis.

W82-70249 **506-61-07**
Lyndon B. Johnson Space Center, Houston, Tex.
BUBBLE MEMORY SYSTEM TECHNOLOGY ASSESSMENT
E. A. Dalke 713-483-2851

A mass memory system which supports data processing system, represents a key architectural issue on both the present orbiter vehicle and future space systems. Today's vehicle design reflects heavy reliance on the electromechanical magnetic tapes and/or rotating electromechanical disc systems. Electromechanical devices in a solid state system technology introduces considerable technical and programatic problems. Most solid state mass memory technologies reflect unique technical and programatic issues including volatility, density, radiation susceptibility, which makes them unattractive. Solid state bubble memory technology appears to be at a development state where it could satisfy space system needs. The objective of this RTOP is to demonstrate the feasibility and applicability of bubble memory to space vehicle mass memory requirement by demonstrating the operation and use in an Orbiter vehicle environment. The RTOP further demonstrates a technology transfer of work initiated by the NASA Research Technology Program managed by Headquarters and pursued by the appropriate development center. The approach is to employ commercially available devices to develop a one-for-one breadboard system replacement of the present Orbiter mass memory unit. The implementation will allow bubbles to be evaluated in a systems environment which will demonstrate performance capabilities, and identify potential flight system development concerns and interface design considerations. This development is a one year program. The approach includes significant coordination with continuing bubble technology development at LaRC to ensure the design architecture supports technology and performance upgrade in consonance with that research.

W82-70250 **506-61-09**
Marshall Space Flight Center, Huntsville, Ala.
NASA END-TO-END DATA SYSTEM (NEEDS): DATA BASE MANAGEMENT/ARCHIVAL MASS MEMORY
D. T. Thomas 205-453-3577

The objectives are to develop and demonstrate a low cost modular data base management system (DBMS) that will accept space acquired and ancillary support data at high rates. The data will be catalogued and then moved through the system at rates up to 50 M bits/sec with the use of a fiber optic bus and parallel data transfer. The other objective is to design, develop, and demonstrate a 10 to the 13th power bit (10 to the 11th power bits on-line) digital optical disk archival mass memory system. This system will receive, record, and play back data at rates up to 50 Mb/sec. The system will be modularly conceived such that total capacity can be expanded to 10 to the 15th power bits without significant redesign. The optical disk will be used as the basic storage medium. Each disk will contain approximately 10 to the 11th power bits of user data.

W82-70251 **506-61-15**
Jet Propulsion Laboratory, Pasadena, Calif.
ANALYSIS OF DEEP SPACE INFORMATION SYSTEMS (ADSIS)
Charles A. Beswick 213-577-9548
(506-19-30; 506-61-55; 540-01-15)

This task (ADSIS) supports the OAST technological program in connection with the Deep Space Mission component of the NASA End-to-End Data System (NEEDS). The long range objectives are: (1) to develop appropriate methodology and supporting tools for end-to-end information system analysis and design; (2) to identify high leverage areas which would benefit from further technological development, and (3) to develop methodology for assessing the impact of technology on the OAST NEEDS program. The method of achieving these technical objectives centers on the development of a system model of EEIS for planetary missions. This model will predict the cost and performance characteristics of alternative EEIS designs (in the context of a given mission scenario) and will allow the identification of potential technology improvements in the overall system configuration. This model may be used by management to address strategic questions such as the impact of multimission design alternatives. The model will also be useful to mission planners in investigating specific design tradeoffs.

W82-70252 **506-61-23**
Langley Research Center, Hampton, Va.
SOFTWARE SUPPORT SYSTEM TOOLS AND TECHNOLOGY
E. C. Foudriat 804-827-2077
(506-19-63)

The objective of this RTOP is to define and develop software tools and technology which will support the information system programs research within NASA. This implies software tools, special purpose computer systems and digital electronic devices, for example, in real-time on-board processing, special purpose parallel processing, etc. as well as general purpose computers. To be effective, the tools must involve the user (e.g., programer, researcher, flight test engineer) in all stages of program development and checkout so he maintains visibility and continuity with high program objectives. It must also keep pace with the rapidly advancing and changing computer hardware developments. The approach is to develop flexible software language systems, validation, and test procedures whereby the particular hardware characteristics system can be made semi transparent yet efficient to the user. These software techniques will be developed and tested by application to NASA flight test programs and will be available to NASA, other government agencies, universities, and industry.

W82-70253 **506-61-25**
Jet Propulsion Laboratory, Pasadena, Calif.
SOFTWARE SYSTEMS ENGINEERING
E. D. Callender 213-354-2405

The objective of this effort is to develop software systems engineering as an ascendant technology within NASA by extending the application of software design methodologies and associated tools. Software engineering has emerged as a critical element of all planetary missions, both as a cost driver and as a major source of schedule and performance uncertainty. Many software tasks within NASA are still being engineered in bottom up, unstructured fashion which provides little management visibility into the progress of work, or potential future problems. During FY-81, a baseline report on the status of software engineering at JPL was prepared (reference 1). The report indicated that

one of the major leverage points for increased cost reduction in producing software is in the user design (requirements analysis)/ top level implementation design area. Hence this RTOP focuses the area of software design. After FY-82, the scope of the RTOP will be expanded to include the other major aspects of software engineering, namely, programming environment, programming languages, data base, test, and operating systems.

W82-70254 **506-61-26**
Goddard Space Flight Center, Greenbelt, Md.
MPP SOFTWARE RESEARCH AND TECHNOLOGY
K. R. Wallgren 301-344-5184
(506-61-01)

The objective of the MPP Software Research and Technology RTOP is to develop systems level software critical to the Massively Parallel Processor (MPP). This software will provide tools, techniques, and languages to allow applications programmers to efficiently develop discipline specific software. This minimal systems software will provide the ability to demonstrate and test applications programs on the MPP. The approach consists of developing software modules at the systems level. This includes critical MPP interrupt control routines, compiler(s), simulator, and software demonstration routines. The FY-81 accomplishments will include: completion of MPP software simulator, completion of the evaluation version of Parallel Pascal, and generation of 42 primitives for the image processing library.

W82-70255 **506-61-33**
Langley Research Center, Hampton, Va.
ON-BOARD INFORMATION SYSTEMS
C. Husson 804-827-3535
(506-61-23)

The objective of this work is to investigate and develop new signal and information processing concepts and related technologies to enhance the performance of operational and analytical spacecraft systems in the Shuttle era. That is, to investigate and develop the algorithms and appropriate integrated circuit technologies over the 1980 to 1990 time frame. The specific objective is to develop stand alone, lightweight, real time programmable processors for data manipulation and computational applications related to high data rate sensors, active control of large scale structures and suitable for analysis of Landsat multispectral data. This objective includes the development and implementation of functional transform primitive operators. Current research efforts include the development and practical implementation of new mathematical transforms and higher order subsystem integrated circuit primitives usable in spacecraft information processing systems. This program will identify and characterize the necessary algorithms system architectures, and appropriate *technologies that influence integrated chip design. Also, this* program will identify and analyze candidate algorithms prior to their decomposition into specific hardware or software approaches; and from this analysis develop information processing techniques and devices for high speed, low cost, on-board information processing systems.

W82-70256 **506-61-35**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED DIGITAL SAR PROCESSOR
C. Bode 213-354-7473

The objective of this RTOP is to develop high throughput synthetic radar (SAR) data processor technology to meet the requirements of future space missions. A system design of an advanced digital SAR processor (ADSP) will be completed. This design will be based on the technology expected to be available in the mid 1980's. An engineering model of the azimuth correlator will be developed by the end of FY-85. This azimuth correlator will be capable of about 1/10 real time for a mission that is *four look, 15 meter resolution, 40 to 50 kilometer swath, and* a 60 incident angle. The azimuth correlator will be modularly expandable to do real time processing. If funding permits, a range correlator will be added to demonstrate a full 1/10 throughput capability.

W82-70257 **506-61-42**
Lewis Research Center, Cleveland, Ohio.
HIGH EFFICIENCY TECHNOLOGY FOR MICROWAVE AMPLIFIERS
R. E. Alexovich 216-433-6689
(506-54-42; 541-02-12; 650-60-22)

The objective of this RTOP is to provide, through research, design data, and tests, the technology base for development of high efficiency, high power microwave amplifiers for space and *airborne applications, capable of real time handling of data in* space and state-of-art jamming power in electronic countermeasure systems. To achieve this objective research and technology development programs will be undertaken on several types of microwave amplifiers applicable to high efficiency requirements from 1 to 200 GHz. Specific techniques such as multistage depressed collectors and spent beam refocusing and development of methods for high efficiency performance in the linear, low distortion region will be pursued. Investigation of low loss, high efficiency circuits will be continued.

W82-70258 **506-61-43**
Langley Research Center, Hampton, Va.
MULTIPLE BEAM ANTENNA FEED TECHNOLOGY DEVELOPMENT PROGRAM FOR LARGE APERTURE DEPLOYABLE REFLECTORS
Thomas G. Campbell 804-827-3581
(506-62-43)

The overall objective of this RTOP is to specifically address the development of analysis methods for multiple beam antenna feed (MBAF) technology that are compatible with the technology development activities of the deployable reflector concepts presently funded by code RS of OAST. The development of multiple beam feed technology that is specifically related to the large aperture antenna development will eventually provide NASA *the capability of predicting the total antenna system performance* characteristics for a wide range of mission applications (communication, radiometer, and radio astronomy). Primarily, this activity shall provide a top-level basis for determining the effectiveness of large off-set reflector systems (with up to 200 beams) that are presently being considered for communications and radiometer near-term and far-term missions. Tasks to be accomplished include: the development of the feed requirements for communication and radiometer (PBMR,...) missions for multiple beams and multiple apertures; antenna configuration design for the point design; multiple beam antenna feed point design; and derivation of secondary illumination and multiple beam contour for co-polar and cross-polar plots, spherical near-field testing using subscale models.

W82-70259 **506-61-45**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH SPEED DATA TRANSFER: X/S BAND COMPONENTS
J. F. Boreham 213-354-4107

The general objectives of this RTOP are to develop microwave subsystems and techniques for deep space and related missions which: (1) increase data transfer by a factor of 10 to 100, (2) improve radio navigation accuracy by factors of 10 to 100, (3) improve carrier tracking stability by two orders of magnitude, (4) improve communications component reliability by a factor of two, and (5) reduce cost and weight of these components by at least one third. The approach incorporates the following key items: (1) developmment of the flight equipment for an X-band uplink capability in two phases: (a) develop a down converter to interface with a NASA Standard Deep Space Transponder with a flight engineering experiment demonstration on an ISPM like mission, (b) develop an integrated X-band transponder with wide band ranging, improved phase and group delay stability and adaptability to multiple frequency operation as a long term solution for the late 1980's and beyond, and (c) develop remaining X-band RFS components; (2) Develop X-band Solid State Power Amplifiers (XSSPA's) in two phases: (a) develop 10 to 40 watt XSSPA's *with overall DC to RF efficiencies of approximately* 30 percent as replacements for the expensive and relatively unreliable TWTA's and (b) using the technologies developed for the XSSPA's further develop the very high power capability of the Array Feed

Power Amplifier concept whose feasibility was demonstrated in FY-78, -79. Using this capability missions with excess or low cost, electric power will be able to increase their ERP through the use of transmitter powers up to several hundreds of watts; and (3) perform flight and ground system tradeoff studies to determine the most cost effective, weight efficient, and low risk means of achieving the greater telecommunications performances needed for future deep space missions.

W82-70260 **506-61-46**
Goddard Space Flight Center, Greenbelt, Md.
MICROWAVE/OPTICAL COMPONENTS AND TECHNIQUES
J. S. Chitwood 301-344-8384

The objective is to advance spacecraft technology in data transfer techniques to satisfy the communications requirements of future flight programs. Spacecraft components, techniques, and circuits will be developed to support flight programs characterized by high data rates, simultaneous multiple links, and reliable long life operation. Expected results include: the development of high data rate modulator/exciters, high power amplifiers, low noise receivers, and other advanced data transfer system concepts. Specific accomplishments for FY-82 are: completion of protoflight Ku band modulator/exciter, 60 GHz modulator/exciter critical design review, completion of 60 GHz receiver breadboard, completion of high data rate satellite communications study, and dielectric horn array critical design review.

W82-70261 **506-61-51**
Ames Research Center, Moffett Field, Calif.
FAR INFRARED SENSORS
C. R. McCreight 415-965-6525
(506-61-81; 506-61-53; 159-41-06)

The objective of this RTOP is to develop advanced infrared detection systems for astronomical research. This program will provide the technology for new and more efficient data acquisition capability throughout the infrared (IR) spectrum (2 to 200 microns) for the low-background astronomical application. It will benefit the entire NASA IR astronomy program including future programs such as the Shuttle Infrared Telescope Facility (SIRTF) and the Large Deployable Reflector (LDR), and the on-going ground-based, airborne, and balloon-borne programs. Activities will include development of hybrid and monolithic arrays of high-sensitivity extrinsic and intrinsic detectors, and improved discrete components for eventual array applications. Infrared array expertise developed by the Department of Defense (DoD) and NASA will be used for wavelengths below 30 microns. New IR arrays will be developed for wavelengths beyond 30 microns. Activities will also include development of real-time data preprocessing/data compression electronics for use with the arrays. The IR detector expertise in industry will largely be used for design, fabrication, and preliminary testing of the arrays. Detailed evaluation of the arrays and electronics will be carried out at Ames and also at university facilities by interested IR astronomers. Realistic observational demonstrations will be conducted using ground-based and airborne telescopes. All work performed under this RTOP will be closely coordinated with related DoD and NASA activities.

W82-70262 **506-61-53**
Langley Research Center, Hampton, Va.
INFRARED SENSOR SYSTEMS
W. D. Mace 804-827-3745

The objective of this research is to develop and evaluate infrared sensors that will provide a tenfold increase in usable data acquisition through improvements in sensitivity, resolution, and increased spectral range for applications in aerospace missions such as atmospheric, remote sensing, environmental, geological, agricultural, pollution, and planetary monitoring. In the evaluation process an advanced aircraft test bed will be developed to provide for the testing of the linear arrays, new scanner technology, improved spectral scanning techniques, the calibration and compensation technology and adaptation of smart sensor and data processing technology. The main thrusts are: (1) to develop monolithic indium antimonide detector arrays (1 to 5.5 micrometers) with on chip signal processing and readout of infrared sensors utilizing charge coupled (CCD) technology; (2) to develop mercury cadmium telluride monolithic infrared arrays (2 to 30 micrometers) utilizing CCD technology; (3) to develop multi GigaHertz bandwidth photomixers; (4) to develop calibration-compensated techniques for multispectral scanners; and (5) to develop and demonstrate through an advanced aircraft scanner test-bed the above imaging array technology. Materials processing, device, and fabrication technology will be developed for improved signal to noise ratios, increased resolution, and broader spectral sensitivity. Advanced scanner techniques will be developed to test and evaluate the new pushbroom linear imager technology along with the development of calibration technology.

W82-70263 **506-61-55**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED DETECTOR ARRAY DEVELOPMENT
Martin Lonky 213-354-7222

The objectives of this program are to develop infrared detector arrays and to demonstrate IR array instrument systems applicable to future NASA remote sensing missions. The objectives also include detailed parametric characterization of infrared detector capabilities. The approach to the development of infrared detector arrays consists of four interrelated activities: requirements definition, technology development, experimental evaluations, and demonstration in remote sensing instrumentation. The array requirements for future planetary missions have been documented. Technology development includes both the in-house analysis and engineering trade studies and a sub-contracted design fabrication and test program. An in-house test program is crucial to the effort because it permits an independent verification of array performance and a more detailed evaluation of those device parameters which are of prime importance in NASA's remote sensing programs. The results of the evaluation of detector performance will be factored into the array development at the contractor. Arrays will be demonstrated in the Airborne Mapping spectrometer, geologic remote sensing instrument which utilizes area arrays to acquire simultaneous spatial and spectral information utilizing a pushbroom imaging mode. This terrestrial application is directly analogous to the Galileo Near Infrared Mapping Spectrometer which will map the Galilean Satellites and explore Jupiter's atmosphere.

W82-70264 **506-61-56**
Goddard Space Flight Center, Greenbelt, Md.
SENSOR SYSTEMS-INFRARED LINEAR ARRAY DEVELOPMENT
M. Ritter 301-344-8382

The objective of this RTOP is to develop and flight-test advanced infrared sensing systems to extend the performance capability of Multispectral Linear Array (MLA) instruments that are expected to fly on future Earth observation satellites. Current MLA sensors are generally limited to using silicon detector arrays which cover the spectral region from 0.4 to 1 micrometer. The effort under this RTOP is directed towards development, flight test, and evaluation of MLA sensor systems that operate in the 1 to 4 and 8 to 12 micrometer spectral regions. The 8 to 12 micron region is emphasized. The sensors will incorporate photovoltaic HgCdTe detectors coupled to Si charge coupled device multiplexers. A sensor system with a 1000-element linear detector array is under development and will be optimized for viewing terrestrial targets which have a high thermal background. Laboratory development of SWIR sensors will also be continued. Wide-field angle, all reflective optical systems have been designed, sensor modeling studies will be conducted and special infrared sensor system calibration techniques and test facilities are under development. Infrared sensor systems that utilize self-scanned linear detector arrays that operate in the 1 to 4 and 8 to 12 micrometer spectral region will be developed and laboratory and aircraft evaluation programs will be conducted. Photovoltaic HgCdTe thermal arrays will be made available for spacecraft sensor systems.

W82-70265 **506-61-63**
Langley Research Center, Hampton, Va.
BROADBAND RADIOMETERS
Richard F. Harrington 804-827-3631

The objective of this program is to design, develop and test broadband passive microwave systems to permit radiometric measurements to be made of the Earth and its environment on an all weather basis and with significantly improved spatial resolution, sensitivity and areal coverage. The specific approach includes the development of low loss microwave integrated circuit radiometer front-ends for noise injection, closed loop, Dicke switched radiometers and the development of a pushbroom microwave radiometer. This radiometer consists of five fixed freqency 1.4 GHz radiometers in a pushbroom array, a 1.8 to 2.8 GHz stepped frequency radiometer and a 3.8 to 5.8 GHz stepped frequency radiometer. The measurement capability of the pushbroom microwave radiometer will be demonstrated in an aircraft flight test program. Studies will be performed to determine the optimum multibeam radiometer configuration for large space structure radiometric systems and the optimum radiometric measurement techniques. These studies cover the microwave, millimeter and sub-millimeter frequency regions.

W82-70266 **506-61-65**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF SUBMILLIMETER WAVELENGTH COMPONENTS
H. M. Pickett 213-354-6861
(147-10-02; 147-20-03; 188-41-55; 196-41-73)

This RTOP is for a task to develop low-noise, coherent, submillimeter wavelength receivers for multifunctional uses. The goal of the task is to provide the technological developments necessary for constructing low-noise receivers operating up to 3000 GHz (0.10 mm wavelength). These receivers will be of importance to areas of the space program in the time period beyond 1985 including terrestrial atmospheric observations from aircraft, balloon and Earth orbit: astronomical observations from aircraft and orbit; missions to planets and comets; and supporting laboratory spectroscopy. Measurement needs of upper atmospheric research require that these receivers be developed as soon as possible. At present no adequate technique exists for global monitoring during both day and nightime conditions of the chemically active species atomic O, OH, HC, and others. Measurement of these species in the upper atmosphere is of recognized importance for assessing the extent to which man's technological activities may be affecting Earth's protective ozone layer. These species can be measured with submillimeter receivers, which for some of the species may be the only means for their measurement. A Microwave Limb Sounder (MLS) has recently been flown on balloon using similar techniques at a lower frequency and has been used to measure CO and O3. A MLS has been included in the initial instrument selection for the Upper Atmospheric Research Satellite (UARS) and a similar instrument is being developed for OSTA shuttle missions. The technology being developed under this RTOP can be used in follow-on MLS missions to greatly enhance its measurement capability. Five major component areas must be addressed: (1) development of quasi-optical techniques for submillimeter receiver front ends; (2) development of techniques for coupling of submillimeter radiation to nonlinear devices; (3) development of nonlinear devices capable of efficient operation at submillimeter wavelengths; (4) development of local oscillator sources; and (5) demonstration of receiver systems in the laboratory and on aircraft.

W82-70267 **506-61-66**
Goddard Space Flight Center, Greenbelt, Md.
MULTIFUNCTION MICROWAVES
J. K. King 301-344-8949

The objective is to develop advanced technology and system concepts for active and passive microwave sensing of the Earth's environment. Sensor systems are designed in frequency bands from 1 to 225 GHz to measure atmospheric temperature and water vapor, precipitation, sea surface temperature (SST) and wind speed (WS), soil moisture (SM), and sea ice types and concentrations. Advanced radiometer receiver technology is developed in the 90 to 225 GHz region including Schottky barrier gallium arsenide diodes and subharmonic mixers which are flown on high altitude aircraft by application's meteorology programs. Multichannel (1.4, 4.3, 5.3, 10.7 GHz) multibeam (48) mechanically scanned (6 RPM) 15 meter diameter deployable antennas are being studied to measure SST, soil moisture, and precipitation. Mechanical and electrical analytical models of these large antennas are being developed to show system feasibility. Three deployable antenna vendors are under contract to deliver NASTRAN structural models and antenna performance estimates. Parallel in-house modelling and system analysis of the 15 meter system is being used to check study results and form independent assessments of the various system performance. One of the three deployable antenna approaches will be selected for further study in FY-82. A new geosynchronous satellite synthetic aperture radiometer system approach will also be evaluated in FY-82. Lower noise (6 db noise figure) 183 GHz subharmonic mixers with improved reliability will be developed.

W82-70268 **506-61-67**
Lyndon B. Johnson Space Center, Houston, Tex.
MULTIFUNCTION SAR TECHNOLOGY
K. Krishen 713-483-2846

Synthetic Aperture Radar (SAR) systems provide day/night, nearly all weather, high resolution data not available with sensors in the other parts of the electromagnetic spectrum. Recent NASA Active Microwave Remote Sensing Research Program Plan identifies several unique Earth resources applications of SAR's. The potential of SAR's for these applications can only be established in a limited manner with the presently available SAR capabilities which include single-frequency, single-polarization, and swath widths up to 100 km. The objective of the Multifunction SAR Technology Program is to develop technology for the fabrication of multimission spacecraft SAR's capable of operating at selectable frequency(ies), polarization(s), bandwidth, incidence angle(s), and wide-swath with improved spatial resolution and calibration. The immediate goal is to conduct studies, design, fabricate, and conduct performance tests for advanced antenna systems, calibration subsystems, high power transmitters, advanced distributed array SAR, and multibeam squint mode SAR to allow fabrication of SAR systems with new functional and performance capabilities for missions planned for the 1985 to 1995 period. Demonstration of the new technology will be accomplished through laboratory, aircraft, or spacecraft testing on a subsystem level for the most efficient use of the resources. Other technology areas which include pixel elevation mapping, frequency agile/diversity SAR, phase/polarization mapping, and bistatic SAR will also be identified and prioritized for future development.

W82-70269 **506-61-73**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION LASER SENSING SYSTEMS: ELECTRO-OPTICAL SENSORS
S. L. Ocheltree 804-827-2179
(506-54-43)

The objective of this research is to investigate advanced laser and electro-optic sensor concepts, develop systems technology, and perform systems level laboratory and field technology demonstrations for remote and in situ sensing of atmosphere properties. Specific sensor areas to be investigated are passive laser heterodyne system technology for remote measurement of the atmospheric species and active laser (LIDAR) sensing system technology for remote high vertical resolution measurements of atmospheric species, wind velocities, shear, and turbulence from ground, aircraft, and spacecraft platforms.

W82-70270 **506-61-75**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH RESOLUTION LASER SYSTEMS: TECHNIQUES FOR ULTRAVIOLET-VISIBLE LASER REMOTE SENSING
James B. Laudenslager 213-354-2259
(506-54-45)

The long term objective of the High Resolution Lasers task is to demonstrate a compact, tunable UV gas discharge laser on a systems level for remote detection of trace atmospheric

species. The UV or visible laser will first be developed as a laboratory breadboard system to demonstrate species detection and then this laser breadboard will be modified for testing of active remote species detection from ground level, airplane balloon, or shuttle platforms. A separate Office of Aeronautics and Space Technology (OAST) RTOP is currently funded to develop new types of UV visible lasers and to develop techniques to tune the lasers. It is the goal of this RTOP to take the lasers developed in the other OAST task and to first identify and develop a remote sensing experiment for detection of atmospherically important species and then to develop a breadboard laser system to meet the particular specifications required by that measurement. In order to achieve these objectives, a state of the art high resolution computerized UV visible laser spectroscopy laboratory facility has been assembled to identify and develop remote sensing methods for detection of atmospherically important species such as OH and NO molecules. It is important to do the basic supporting spectroscopy to develop visible remote sensing experiments as well as to provide the necessary quantitative spectroscopic and kinetic constants required by the Lidar equation or extract species concentrations from the backscattered fluorescence return signal. It is the purpose of this task to build compact and reliable tunable laser systems for remote sensing of atmospheric species such as OH radicals. Breadboarding a laser sensing experiment for remote sensing of OH radicals with a XeC excimer laser requires the laser to be operated with a spectral bandwidth on the order of the Doppler width of an OH absorption line, 0.001nm, and the laser has to be tunable on and off OH absorption lines.

W82-70271 **506-61-76**
Goddard Space Flight Center, Greenbelt, Md.
HIGH RESOLUTION LASER SYSTEMS
J. J. Degnan 301-344-7714
(676-59-36; 692-20-00; 146-60-01; 506-54-46)

The overall objective of this RTOP is to develop lasers and laser-related components and instruments in support of NASA programs in geophysics, astronomy, and the atmospheric sciences. There are four elements in the RTOP. A brief summary of the technical objectives and approaches for each element follows. The subnanosecond pulse laser ranging/altimetry task is to develop components and systems capable of one cm accuracy for geophysics and time transfer applications and to develop subnanosecond pulse Nd:YAG laser transmitter and 10 picosecond resolution ranging receivers. The submillimeter wave (SMMW) heterodyne spectrometer task is to develop compact, high resolution (1 MHz) SMMW heterodyne spectrometers for astronomical and atmospheric science applications and develop compact, frequency stable SMMW laser local oscillators, and wide bandwidth SMMW mixers and receivers. The long-lived, high peak power dye laser task is to develop long-lived dyes and oscillator/amplifier techniques for high peak powers required for advanced stratospheric lidar system. Basic research related to flashlamp pumped laser dyes, processing and filtering techniques, and injection locking of a regenerative dye amplifier to a modelocked dye oscillator will be performed. The infrared lidar task concerns flight demonstration of airborne infrared lidar systems for remote measurement of tropospheric trace species. The approach is to operate CO2-based differential absorption lidar (DIAL) systems from an aircraft and compare with in-situ measurements of trace species and pollutants.

W82-70272 **506-61-81**
Ames Research Center, Moffett Field, Calif.
CRYOGENIC SYSTEMS AND OPTICS TECHNOLOGY (<10K
P. Kittel 415-965-6525
(506-61-51; 506-56-21; 441-41-06)

The objective of this effort is to provide space compatible technology for detectors requiring operating temperatures between 10 and 0.1 Kelvin. The first element, cryogenic systems, provides the following: Liquid helium dewar technology will be advanced by investigations to develop a long life launchable dewar and by follow-up studies of the problems found in IRAS; low temperature refrigeration technology will be advanced with two separate space-compatible cooling techniques; low temperature electronics will be advanced with studies of silicon on sapphire, superconducting and conventional devices; low temperature optics technology will be advanced with an investigation of infrared filters. The second element, mirror testing, provides the following: Mirror material technology will be advanced for use of glass at liquid helium temperatures; selection of materials will be enabled by making LHe measurements on small samples of materials and actual representative mirrors (approx. 0.5 meter diameter).

W82-70273 **506-61-85**
Jet Propulsion Laboratory, Pasadena, Calif.
SENSOR COOLING SYSTEMS
D. D. Elleman 213-354-5182

The objective of this program is to develop and demonstrate, prototype spacecraft cooling systems which can satisfy requirements of both terrestrial and extraterrestrial missions, whose instruments and detectors must be cooled to low temperatures (2-250 deg K). A past JPL study identified areas where available technology is inadequate to meet instrument cooling needs and recommended how the differences could be remedied. Requirements for at least ten planned instruments cannot be satisfied by existing technology. Candidate cooling approaches for these and similar systems are: (1) passive radiation (60 to 90 deg K); (2) magnetic refrigerators (mK to 250 deg K); (3) gas adsorption refrigerators (0.3 to 250 K); (4) the novel mechanical refrigerators being developed at GSFC (40 to 80 deg K); and, (5) a miniature refrigerator being developed by Stanford and JPL. The systems to be developed in this program will use a suitable combination of these refrigeration techniques. The applicability and availability of DoD flight refrigeration technology is being assessed. The main deliverables will be tested prototype models of spacecraft cryogenic systems that satisfy mission requirements. The two major task activities are advanced research and development, and system design and development.

W82-70274 **506-61-86**
Goddard Space Flight Center, Greenbelt, Md.
SENSOR COOLING SYSTEMS AND INTERACTIVE ELECTRO-OPTICS INSTRUMENT SIMULATIONS
A. Sherman 301-344-5405

This RTOP provides support for advanced sensor systems. The overall objective of the cryogenics program is to provide mechanical cooler and solid cryogen technology, which will be applicable to the large number of future missions that will require instrument cryogenic cooling. The approach for the mechanical cooler and program is: (1) develop 3 to 5 year, 65 deg K, lifetime cooler technology and prototype models utilizing a linear drive, and non-contacting bearings and seals; and (2) extend the 3 to 5 year technology to the development of a 12 deg K mechanical cooler. The objectives of the solid cryogenic program are to extend the temperature capability down to 10 deg K. In addition, an expanded data base for the properties of instrument optical components at cryogenic temperatures will be generated. The program approach includes technology demonstration tests and systems development. The objective of the instrument simulation program is to configure state-of-the-art hardware and software to provide an instrument system simulator with interactive and real time capabilities for use by engineers and scientists in the design development, analysis and parametric study of instrument concepts. The expected result is an advanced analytical system which provides a systematic, highly visible, interactive and real time approach for establishing optimum instrument specifications and assessing expected instrument system performance (including the ground data processing algorithms).

W82-70275 **506-61-93**
Langley Research Center, Hampton, Va.
INSTRUMENT POINTING SYSTEMS
C. R. Keckler 804-827-3917

The objectives of this RTOP are to develop, demonstrate, and verify techniques and systems capable of providing high accuracy pointing and stability (approximately 0.01 arc seconds) for a large range of experiments dedicated to stellar, solar, and terrestrial observations, as well as interplanetary investigations. To achieve these goals, new concepts, devices, and analyses are being pursued. These include the development of techniques and systems associated with the Annular Suspension and Pointing

System (ASPS) to provide the high accuracy pointing and stabilization of future payloads. The ASPS is a modular system utilizing conventional gimbals and advanced magnetic suspension to provide payload isolation from external disturbances and to satisfy the stringent control requirements of various experiments. Through these efforts, technology is being established for a multimission, highly accurate and stable platform capable of achieving the objectives of Shuttle experiments, while insuring maximum returns for minimum costs. Components, subassemblies, and systems are developed, tested, and modeled to permit the predicting of on-orbit performance via computer simulations. Establishment of 'optimized' software and hardware results from these efforts. This system will then be verified in the orbit environment onboard the STS. These efforts are directly coordinated with other NASA centers, DOD, and the science community.

W82-70276 **506-61-95**
Jet Propulsion Laboratory, Pasadena, Calif.
PRECISION POINTING AND TRACKING SYSTEM (PPTS)
L. F. McGlinchey 213-354-4716
(506-54-75; 506-54-85)

The long range objective of this RTOP is to develop a precision science platform articulation system which is capable of meeting requirements of a wide range of future unmanned, planetary missions. These requirements include: pointing accuracy and stability, long life, greater onboard autonomy, and lower operating costs. The approach for meeting this objective includes several distinct elements: (1) design and develop a target-referenced, inertially stabilized platform and demonstrate 10 arc sec pointing accuracy and 0.2 arc sec stability; (2) development of high level command capability to remove much of ground planning burden (i.e., command 'full disk mosaic' rather than picture-by-picture details); (3) develop and demonstrate target recognition and feature-tracking capability as a follow on to the target body tracker previously developed under this RTOP; (4) integration of these elements, and emerging technologies, such as the Fiber Optics Rotation Sensor (FORS/506-54-85), into system level demonstration tests. Tests will include the simplified uplink/downlink proposed for missions in the nineties, and air bearing table to simulate S/C motion, precision attitude and target-vector references, and a variety of realistic optical simulations. FY-82 plans include breadboard system integration, initiation of pointing accuracy test, and three axis system design and modeling. As a step toward greater onboard pointing system autonomy, high level command expansion and feature tracking concepts will also be developed.

Spacecraft Systems Research and Technology

W82-70277 **506-62-26**
Goddard Space Flight Center, Greenbelt, Md.
INTEGRATED ANALYSIS AND DESIGN
J. P. Young 301-344-8284

The objective is to produce an interdisciplinary analysis system capable of performing design analyses of large space systems whereby disciplines such as thermal, structures, controls, electromagnetic radiation, and optics can be coupled to act interactively in a highly efficient manner. The system is to be designed so as to permit rapid and efficient automated two way flow of data between all the analysis modules. Key design goals are to make the system highly interactive in the math model building, interdisciplinary data transfer, and data query modes; to function either stand alone or interfaced with IPAD; and to build an open ended system that is specifically designed to accept new analysis capabilities to satisfy individual user organizations needs. The system is to have the basic capability to support the wide span of design phases ranging from conceptual to final verification stages. The primary thrust of this analysis capability will be to identify the critical interactive effects on system design aspects such as loads, structural integrity, control stability, and mission performance. In addition, once a deficiency in performance has been identified, the analysis system is to provide the capability to rapidly evaluate various design change options in search of the most suitable solution. The Level I IAC (Integrated Analysis Capability) is scheduled for delivery in August 1982.

W82-70278 **506-62-41**
Ames Research Center, Moffett Field, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTOR FOR INFRARED & SUBMILLIMETER ASTRONOMY
M. Kiya 415-965-5708
(506-61-31; 506-61-41; 358-41-06)

The objective of this RTOP is to assess and develop the technologies identified in the feasibility and system concept definition study (completed by Lockheed in July 1980) as critical, and to design and fabricate the Large Deployable Reflector (LDR). Several technologies identified and requiring development are: segmented mirrors; figure and pointing control; thermal control; support structures; and deployment technique. The approach is to continue the technology assessment in these most critical areas and initiate development activities for mirror segments in FY-82.

W82-70279 **506-62-42**
Lewis Research Center, Cleveland, Ohio.
LARGE SPACE STRUCTURE SYSTEMS: SPACECRAFT PROPULSION SYSTEMS
Martin E. Valgora 216-433-4000
(506-52-42; 506-55-22; 506-55-32)

The objective of this effort is to define and develop system level technology requirements for chemical and electrical propulsion systems and power for electrical propulsion applicable to large space systems. Spacecraft systems will be analyzed to determine which missions can best be supported by the alternative propulsion choices. These studies will develop a technology and cost data base to assist in guiding decisions on which propulsion technologies have the highest potential. These studies will determine performance requirements, identify system constraints, estimate cost, weight and size of potential propulsion systems, identify new technology needs, and determine benefit/cost ratios of proposed technology programs.

W82-70280 **506-62-43**
Langley Research Center, Hampton, Va.
LARGE SPACE ANTENNA RESEARCH AND TECHNOLOGY DEVELOPMENT
W. Ray Hook 804-827-3666

Promising antenna system concepts and their critical supporting technologies are being analyzed, developed, and tested to meet National needs of the 80's and 90's. Spacecraft analysis is underway for communications and microwave Earth observation missions while assessments are carried out for more advanced missions in order to provide guidance for future research and development. Development activities include the evaluation of erectable and deployable antenna concepts through ground test and analysis. Supporting technology efforts are underway in electromagnetic analysis, advanced system state estimation for control, electrostatic reflector surface formation and control, and advanced spacecraft system analysis techniques. Further, a larger body of disciplinary research applicable to large space antennas is coordinated with this effort in order to provide a focus for Langley Research Center's spacecraft technology work.

W82-70281 **506-62-45**
Jet Propulsion Laboratory, Pasadena, Calif.
LARGE SPACE STRUCTURE SYSTEMS - ANTENNA CONCEPT DEVELOPMENT AND LSS CONTROL TECHNOLOGY
R. E. Freeland 213-354-3540
(506-54-75)

The long range objectives of this RTOP are: (1) to develop the offset wrap-rib deployable antenna concept to the point of technology readiness for classes of potential applications through conceptual development, breadboard hardware testing, functional component and model testing, and predictive analysis for performance projection; (2) and to identify and develop fundamen-

tal control technology required for the precise attitude and shape control of large antenna and platform systems currently in planning for the late 1980's and beyond. The antenna concept development includes: (1) the design of the 55-meter diameter proof of concept hardware along with the design and fabrication of the tooling needed to produce the graphite/epoxy ribs and mesh gores; (2) the fabrication of the rib structure, mesh panels, and hub structure; (3) the assembly of 'proof of concept' hardware; and (4) the testing whose results will be the basis of the 100-meter diameter point design. The Large Space Structure (LSS) control technology work includes the following major tasks: (1) control of large antennas-synthesize and evaluate analytical control system designs for offset-fed and hoop-column antennas; (2) control of LSS reference platform-develop and evaluate payload and bus controller designs which provide reduced sensitivity to parameter errors and control dynamic interactions; (3) figure control-develop algorithms, software, and instrumentation concepts required for static shape control and determination of a large parabolic reflector; (4) modal determination and control- develop identification algorithms and sensing strategies for off-line and real-time knowledge of flexible spacecraft frequencies and mode shapes; (5) shape determination and control validation-demonstrate experimentally the precise control to a parabolic shape in the presence of overall system uncertainty; and (6) antenna controller designs based on RF performance develop methods for design of antenna control systems using not only geometrical considerations such as RMS surface tolerance but the ultimate RF system performance.

W82-70282 **506-62-47**
Lyndon B. Johnson Space Center, Houston, Tex.
PLATFORM ASSEMBLY - CONSTRUCTION EQUIPMENT
W. S. Beckham, Jr. 713-483-3084

The objective of this RTOP is to develop technology for the construction and servicing equipment needed in the assembly of a large space platform using the Space Shuttle Orbiter as a construction base. Previous studies have identified requirements and defined equipment concepts for construction of space platforms. One critical function in construction operations is the holding and positioning of the platform relative to the Orbiter to facilitate access to specific work zones by the Remote Manipulator Systems (RMS) and by the extravehicular astronauts. A ground test article (GTA) representing a holding and positioning aid (HPA) concept is being fabricated. This RTOP activity will define and evaluate performance criteria and functional capability through test of the GTA in simulated zero-g operation in the Manipulator Development Facility and the Large Area Space Simulator. The berthing and docking function of the interface between the platform and the construction equipment will be evaluated. Based on test results and analysis, technology needs will be assessed and a development program planned for technology issues that would be critical to the development of flight equipment for the Orbiter.

W82-70283 **506-62-49**
Marshall Space Flight Center, Huntsville, Ala.
LARGE SPACE STRUCTURE SYSTEMS (LSSS) PLATFORM SYSTEMS TECHNOLOGY
R. E. Jewell 205-453-0436

This is a systems technology RTOP submission containing five inguideline tasks and two overguideline tasks for FY-82. The tasks address system studies and discipline/subsystem technologies. Systems integration is attained by focusing each task toward the command objective of providing capability for integrated generic space platform systems. The overall objective is to enhance the systems technology data base to enable new platform system capabilities with improved performance and reliability. The approach will be to absorb existing activities and form a multi-year program plan pointed toward demonstrated system technology readiness by 1986-87; and implement and manage an integrated platform system technology program.

W82-70284 **506-62-55**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY AND SOLAR SPACECRAFT SYSTEMS
A. Klumpp 213-354-4209
(506-52-25)

The work described in this RTOP is divided into four tasks. The objective of the Automated Optical Navigation (AON) task is to complete development of AON System for Galileo; enable Voyager 2 to use AON during Uranus encounter; develop technology for AON system to be used for later missions. The standard practices used for developing AON and Space Shuttle on-board software will be continued. The objective of the generic Aerocapture Systems Technology Development task is to develop and demonstrate systems level technologies for a generic aerocapture vehicle system. The Autonomous Spacecraft System Technology task will conduct analyses, define requirements, and develop system concepts for autonomous spacecraft maintenance to reduce cost while maintaining high performance and reliability. The approach will be to characterize an automated version of Voyager spacecraft to delineate potential savings as compared to actual spacecraft while maintaining equivalent performance and reliability. The Space Storable Propulsion Systems Technology task will demonstrate technology readiness of complete spacecraft sized, flightweight F2/N2H4 propulsion system. Propellant loading and hot-fire testing of complete system to a preselected duty cycle typical of a flight application will be performed.

W82-70285 **506-62-61**
Ames Research Center, Moffett Field, Calif.
FAR INFRARED OPTICAL PROPERTIES OF CRYO-CONTAMINATED TELESCOPE SURFACES
S. M. Smith 415-965-6264
(159-41-06; 441-41-06)

The objective of this RTOP is to investigate the effect of cryogenically condensed contaminants upon the far infrared optical properties of various kinds of cold telescope surfaces. In order to optimize the rejection of stray light, quantitative bidirectional reflectance distribution functions (BRDF), as well as optical constants data, are needed for the design and subsequent operation of the design and subsequent operation of liquid helium cooled telescopes such as the infrared astronomy satellite and SIRTF. Room temperature BRDF data has already been obtained at four wavebands between 12 and 236 microns from laboratory measurement of sample telescope materials on a recently constructed nonspecular reflectometer (NSR) at Ames. Delivery in July 1981 of a liquid helium cryostate with far-infrared transmitting windows will modify the NSR so that the optical properties of cold and cryo-contaminated surfaces can then be measured. The approach for this RTOP is to complete the cryostat modification to the NSR, optimize the stray-light rejection of the instrument itself, and commence a program for far infrared BRDF and optical constants measurement of cryo-contaminated telescope surfaces (mirrors and black coatings). These measurements can be made in passbands with about 15% resolution centered near wavelengths of 12.5, 28, 36, 66, 112, 175, 236, 293, 320, 466, and 700 microns.

W82-70286 **506-62-66**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED EARTH ORBITAL SYSTEMS TECHNOLOGY
P. A. Studer 301-344-5229

The objective of this program is to identify, coordinate, and organize technological advances which will achieve and enhance future Earth orbital mission objectives. The needs of planned and projected missions will be reviewed and compared on a time-line basis with the development cycles of emerging technologies with identifiable potential and applicability to space operations. Cross-fertilization of technological skills and techniques from areas of subsystem expertise will be promoted. Technological advances within and outside the agency will be tracked and transmitted between subsystem disciplines. A near-term objective will be the definition of a systems development plan. An interdisciplinary total spacecraft systems approach to development tasks will be the goal. Working basically from future mission requirements, vital technology needs areas will be identified, the state and pace of their development charted, and results directed

to parallel subsystem developments and eventually flight programs in their earliest phases. The approach will be to avoid duplication and more efficiently utilize resources by transfer of developments and techniques between on-going subsystem specialists and through the communication of accomplishments from research centers to flight system designers. The impact of upcoming technology advances on future mission planning will be assessed and communicated to minimize the lag in systems development and deployment. The primary focus will be on generic elements with broad and continuing functional applications.

W82-70287 **506-62-69**
Marshall Space Flight Center, Huntsville, Ala.
SOLAR ARRAY DYNAMICS, CONTROL, AND POWER FLIGHT EXPERIMENT (FLIGHTS 1 AND 2)
Henry C. Hill 205-453-3423
(542-03-04)

The major objectives of phase one of this task are to develop and demonstrate the technology readiness of on-orbit remote and data processing systems for subsequent use in large space structure dynamic response measurements; and to process the data obtained from the remote sensing tests; and to define solar arrays response data for correlation with theory, ground test data, and response control techniques applicable to large, flexible space systems. Phase two will flight demonstrate the control technology that will be required for the stabilization and pointing of large space systems and test advanced photovoltaic power generation approaches. The approach consists of developing/flight qualifying/flight verifying remote sensing and recording systems for measuring Solar Electric Propulsion Stage (SEPS) Solar Array Experiment X and Y coordinate motions obtained from controlled Orbiter VCS firings; developing/integrating with the SEPS Solar Array Experiment, and Annular Suspension and Pointing System (ASPS) Gimbal System, tip mounted sensor package, and data acquisition system; conducting ground dynamic response proof of concept tests; developing control algorithms; and correlate flight data with analytical/ground test data to define orbit peculiar characteristics. For power, new light weight solar cells and array fabrication techniques and high voltage systems will be monitored for their performance in the actual operating environment.

Transportation Systems Research and Technology

W82-70288 **506-63-23**
Langley Research Center, Hampton, Va.
CONCEPTUAL CHARACTERIZATION AND TECHNOLOGY ASSESSMENT
J. P. Arrington 804-827-3911

The objective of this RTOP is to identify, justify, and prioritize high leverage enabling and enhancing technologies for both current evolutionary and future new space transportation systems. This includes the projection of future transportation needs, the characterization of potential future mission and economic capabilities based on the design of advanced concepts, and the assessment of technology impacts on desired transportation attributes. The approach focuses on the total transportation system, including both Earth-to-orbit and orbital transfer vehicles, which operate primarily within the geosynchronous sphere. The intent is to build on the Space Shuttle technologies which enhance the current Space Transportation System (STS) and enable new systems which have significant cost and/or capability advantages when they will be required as a second generation STS. Technology areas of particular interest include: composite and thermal protection materials, propulsion systems, structural design, aerothermodynamics, design integration, advanced flight control, and automated operations. This activity will be pursued through in-house system studies, selected in-house assessments, contracted system assessments, and intercenter reviews.

W82-70289 **506-63-27**
Lyndon B. Johnson Space Center, Houston, Tex.
AUTOMATION OF SPACE TRANSPORTATION SYSTEMS
Max Engert 713-483-2872

The objective is to assess automations concepts and techniques applicable to advanced transportation systems. Concepts which provide ways of reducing the cost or enabling the performance of the high mission rates of the Shuttle program (circa 1985 and beyond) will also be investigated. Four major tasks are included: (1) automation of the flight operations data base; (2) automation of subsystem management functions; (3) automated fault detection and isolation; and (4) avionics system test bed. A fifth task provides integrating support to the others. The approach is to direct automations related tasks at key space transportation areas involving labor intensive human involvement where advances in technology can make significant reductions in cost through increased overall system efficiency. These areas involve not only the spacecraft flight hardware but also the support systems required to develop the vehicle and perform missions. The avionics systems task recognizes the increasing pervasive and controlling role of the data processing system in highly automated, complex space transportation systems.

W82-70290 **506-63-31**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX (ORBITER EXPERIMENTS) PROJECT SUPPORT
D. G. Wiseman 713-483-3987

The OEX Program was initiated jointly by JSC and OAST to utilize the Space Shuttle as a research vehicle. The program objective is to collect data in the technology disciplines that will augment the research and technology base for future spacecraft design. Flight data relative to these disciplines will be collected by utilizing the currently planned DFI configuration, by modifications and/or augmentations to the present OFT baseline instrumentation and by development of unique experiments beyond the DFI capabilities for flight on the Orbiter. Studies will be conducted to determine the optimum method of utilizing the Shuttle system to conduct research and technology. These studies will be augmented by investigations to develop experimental programs that would obtain research and technology data in flight regimes applicable to advanced space transportation systems. The primary goal of these studies is more efficient utilization of the STS capabilities to obtain data required to advance the current state of spacecraft technology. This RTOP includes the effort associated with overall project management, project support, experiment development initiation, experiment compatibility assessments, experiment integration activities and integration hardware development initiation. The experiment development effort is the subject of additional RTOP's from the appropriate NASA Centers.

W82-70291 **506-63-32**
Langley Research Center, Hampton, Va.
SHUTTLE ENTRY AIR DATA SYSTEM (SEADS)
P. M. Siemers 804-827-3984
(506-51-33)

The objective is to extend the knowledge of aerodynamics, aerothermodynamics, and basic fluid mechanics into flow regimes previously inaccessible to the investigator through extraction of flight data during routine operation of the Shuttle Orbiter. This knowledge will be applied to verify and increase the reliability of sophisticated computational prediction codes, to develop procedures to extrapolate wind tunnel data to flight conditions, to improve the performance and operational capability of STS, and to provide data base for studies of future aeronautical and aerospace vehicles. The design, development, calibration, and demonstration of the Shuttle Entry Air Data System will be accomplished through in house (LaRC) analysis and test programs, and contracted studies. A retrofitted instrumented nose cap, incorporating the Shuttle Entry Air Data System, will obtain flight data which, when reduced, will produce the required air data parameters for each Orbiter flight. These data, in conjunction with inertial data, development flight instrumentation data, and data obtained by specialized instrumentation packages, will be

utilized to verify aerodynamics and aerothermodynamics performance as well as resolve many basic fluid mechanic questions.

W82-70292 **506-63-33**
Lyndon B. Johnson Space Center, Houston, Tex.
ACIP (AERODYNAMIC COEFFICIENT IDENTIFICATION PACKAGE)
Joe F. Rutherford 713-483-4661

The Aerodynamic Coefficient Identification Package (ACIP) experiment provides high quality flight data for post-flight aerodynamic coefficient estimation. Internal ACIP sensors accurately measure linear and angular accelerations and rotational rates at very high sample rates for estimation of triaxial force, moment, and control characteristics. These data support not only the aerodynamic technology area but aerothermal and structural dynamics also.

W82-70293 **506-63-34**
Langley Research Center, Hampton, Va.
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING (SILTS)
J. C. Dunavant 804-827-3984

The objective is to extend the knowledge of the basic aerothermodynamic of leeside flow fields and heat transfer on large lifting vehicles into flow regimes which are inaccessible to investigations in ground facilities through sensing of leeside surface temperatures during Shuttle Orbiter entry with an infrared scanner. These data will permit development of improved leeside flow field and heat transfer prediction techniques which are required to reduce considerably the weight and cost of thermal protection systems on the leeside of future space vehicles. This experiment utilizes a highly developed scanner and recording system which will be qualified for the severe ascent environment in a development program at the Langley Research Center. The instrumentation and supporting equipment will be installed in a Langley manufactured engineering test model and tested at the Langley Research Center. The flight structural pod, exclusive of the dome, will be manufactured by the Shuttle Orbiter contractor; and the experiment will be installed in Orbiter 102 at KSC. The SILTS experiment will be flown on a number of early Orbiter flights.

W82-70294 **506-63-35**
Ames Research Center, Moffett Field, Calif.
INFRARED IMAGERY OF SHUTTLE
B. L. Swenson 415-965-5263
(506-51-31)

The purpose of this RTOP is to design, develop, and conduct an experiment to be used in conjunction with the first orbital flights of Shuttle. The experiment is part of the Orbiter Experiments program (OEX) and will obtain measurements of surface temperature of the lower and side surfaces of the orbiter by means of remote high resolution infrared imagery. This imagery is obtained on board the C-141 Kuiper Airborne Observatory (KAO). The experimental equipment to be developed consists of an acquisition telescope and appropriate servo system, a cryogenically cooled focal plane and detector array, and a data handling and storage system.

W82-70295 **506-63-36**
Ames Research Center, Moffett Field, Calif.
OEX THERMAL PROTECTION EXPERIMENTS
H. K. Larson 415-965-5369

The overall objective of these experiments is to obtain a better understanding of thermal protection system (TPS) reentry heating effects that may permit TPS cost and weight reductions for Shuttle and advanced space transportation systems. Four separate experiments will be flown as test panels or tiles replacing baseline TPS on the Shuttle orbiter during orbiter flight tests (OFT) and operational flights. These experiments will take advantage of the real entry heating environment that cannot be fully simulated in ground facilities to demonstrate advanced TPS materials for possible orbiter retrofit and to investigate TPS heating effects. Temperature data will be obtained with existing and follow-on orbiter instrumentation. Baseline TPS procedures and tooling will be used, and none of the experiments will impact orbiter operations. The experiments will be designed and fabricated by both in-house and contract efforts, and experiments hardware will be provided as GFE.

W82-70296 **506-63-37**
Langley Research Center, Hampton, Va.
SHUTTLE UPPER ATMOSPHERE MASS SPECTROMETER (SUMS)
R. C. Blanchard 804-827-3984
(506-51-13; 506-51-33)

The primary technological objective is to provide flight data for advances in the prediction of aerodynamic behavior throughout the high speed flight regime, including the free molecular flow and the transition into the hypersonic continuum. This objective will be achieved through Shuttle orbiter flight instrumentation, including a Shuttle Upper Atmosphere Mass Spectrometer (SUMS). The specific objective of the SUMS system is to provide in situ high altitude atmospheric data, primarily neutral atmospheric mass density. A spare Viking flight-qualified mass spectrometer will be modified to provide atmospheric data in the rarefied flow flight regime. These data, coupled with data from other proposed experiment systems, will provide aerodynamic information on a winged entry vehicle in flight regimes heretofore unobtainable and will augment ground based test facilities. In addition, experiment results on the Shuttle will provide a benchmark from which to evaluate additional entry technology research. The design, construction, and system tests of the prototype Shuttle Upper Atmosphere Mass Spectrometer (SUMS) and the supporting analysis on the SUMS system design and implementation will bring the experiment to the flight readiness state.

W82-70297 **506-63-38**
Langley Research Center, Hampton, Va.
ORBITER EXPERIMENTS - TITANIUM MULTIWALL THERMAL PROTECTION SYSTEM
G. L. Webb 804-827-3951
(506-53-33)

The objective of this orbiter experiment is to verify the performance of the titanium multiwall thermal protection system (TPS) concept in the total environment (groundhandling, launch, space, entry, and landing) of a space transportation system. To accomplish this objective an array of flat or nearly flat titanium multiwall tiles (up to 25 square feet) will be installed and flight tested on the Shuttle Orbiter in an area that will experience a maximum surface temperature of 1000 F. The experiment will be flown indefinitely, or until thermocouple data or inspection indicates a need to remove the experiment, thereby gaining valuable life cycle data. Langley Research Center will manage the procurement of the qualification hardware, perform the qualification test program, and support JSC in the integration of the flight hardware onto the Orbiter. Johnson Space Center will manage the procurement of the qualification hardware, the integration of the experiment onto the Orbiter, flight test on the Orbiter, and the acquisition of the data. The analysis of data and publishing results will be performed by LaRC.

W82-70298 **506-63-39**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMIC, ACOUSTIC AND THERMAL ENVIRONMENTS (DATE) EXPERIMENT (TRANSPORTATION TECHNOLOGY VERIFICATION -OEX PROGRAM)
William F. Bangs 301-344-7669
(506-53-66)

The DATE Experiment is one of the OAST OEX (Orbiter Experiments) group of STS flight experiments. The DATE Program has, as its major objective, the development and validation of advanced technology for prediction of dynamic, acoustic, and thermal environments and associated payload responses in cargo areas of large reusable space vehicles. The DATE program plans to use environmental data from 7 to 12 early Shuttle flights in support of this advanced technology effort. The early Shuttle flights represent an unusual opportunity to obtain the particular types and quantities of data that are suitable for implementing the DATE program, but would not be included in the environmental data normally acquired for operational purposes.

In FY-82 the objectives will be to continue integration support of delivered calibrated instrumentation for Orbiter flights OSTA-1, OSS-1 and possibly OFT-3 (PDRS); validate the early flight data, coordinate data distribution to participating users, establish implementation plans, and coordinate payload user requirements. This RTOP is limited to acquiring data on flights STS-1, STS-2, STS-3 and STS-4 for originally planned payloads. Planning activities for future flights will continue; however, execution of future flights may be subject to reprogramming considerations. This program is presently a joint funded effort between OAST, USAF, and Chief Engineers Office.

W82-70299 **506-63-41**
Lyndon B. Johnson Space Center, Houston, Tex.
SAMS (SHUTTLE ALTITUDE MEASUREMENT SYSTEM)
H. A. Nitschke 713-483-3073
(506-63-31)

The objective of this plan is to develop a radar altimeter system and integrate the system into the orbiter. The system is to continuously measure orbiter altitude during entry from de-orbit initiation through final landing approach for long term OEX (orbiter experiments) aerothermodynamic research and other research objectives and to provide the data in a format compatible with computer analysis techniques. Residual Viking radar electronics will be modified to be used on the orbiter with a new antenna and control unit based on Viking developments. The antenna will be installed in the left wing glove behind a radome, which will replace the orbiter skin and provide structure for TPS attachment. The antenna and control unit will be located in the payload bay. The control unit will provide for the interface of the SAMS to the SSO (support system for OEX). The SAMS will be activated during descent at de-orbit initiation. Altitude data will be recorded until approximately 10,000 feet above the terrain. After orbiter landing, the OEX tape will be removed, a copy of the tape will be provided to the PT (principal technologist) and CT (co-technologist) at LaRC for processing and analysis.

W82-70300 **506-63-42**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX ADVANCED AUTOPILOT
Edward T. Kubiak 713-483-2094
(506-63-31)

The objective of the OEX Advanced Autopilot experiment is to verify in flight a new and unique autopilot which employs a multi-dimensional phase space rotational and translational control law as an improvement over conventional autopilots which use two dimensional phase plane rotation-only control laws. The advanced autopilot will also employ an optimizing linear jet select algorithm. The new autopilot is principally software which is to be programmed into a shuttle flight computer for the experiment. There its performance can be compared with that of the existing shuttle autopilot.

W82-70301 **506-63-43**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION ACCELEROMETER PACKAGE (HIRAP) EXPERIMENT DEVELOPMENT
R. C. Blanchard 804-827-3984

The primary objective is to provide accurate measurements of low level aerodynamic acceleration along the shuttle orbiter roll, pitch, and yaw axes in the rarefied flow flight regime. This flight data supports advances in the prediction of aerodynamic behavior of winged entry vehicles in the high-speed, low density flight regime, including the free molecular flow and the transition into the hypersonic continuum. An orthogonal triaxial set of linear accelerometers will be mounted on the existing Orbiter Experiment (OEX) ACIP/PCM mounting shelf. Hardware development and integration aspects are accomplished by NASA-JSC, OEX Project Office under a modification to current ACIP I development. Studies under this RTOP will be performed to support the design, development, and calibrations of the HIRAP to achieve experiment objectives. In addition, data reduction algorithms will be designed, developed, tested, and applied.

W82-70302 **506-63-44**
Lyndon B. Johnson Space Center, Houston, Tex.
DICE (DIRECT INPUT TO CONTROL EFFECTORS) EXPERIMENT
D. R. Cooke 713-483-5557

The DICE experiment provides the capability to input preprogrammed maneuvers directly to the control surfaces while inhibiting other control feedback signals. Thus optimum maneuvers can be defined which allow accurate post flight determination of the orbiter vehicle's aerodynamic stability and control characteristics. These characteristics will in turn support the aerodynamic wind tunnel prediction technology area and the development of handling quality criteria for future spacecraft.

W82-70303 **506-63-52**
Lewis Research Center, Cleveland, Ohio.
TRANSPORTATION SYSTEMS TECHNOLOGY DEVELOPMENT
Thomas H. Cochran 216-433-4000

The overall program objective is to identify and develop the technology required for the design of efficient systems to store, acquire (position), and transfer cryogenic fluids in the space environment. The program includes both analysis and ground or space based experimentation with emphasis being placed on reusable insulation, low gravity quantity gauging, liquid acquisition (positioning) and expulsion, fluid transfer, and thermodynamic venting.

W82-70304 **506-63-56**
Goddard Space Flight Center, Greenbelt, Md.
IN-SPACE FLUID MANAGEMENT TECHNOLOGY - GODDARD SUPPORT
Allan Sherman 301-344-5405
(506-63-52)

This RTOP provides manpower to support the In-Space Fluid Management Program managed by the Lewis Research Center. The Cryogenics, Propulsion, and Fluid Systems Branch will provide technical consultation on the supply tank of the Cryogenic Fluid Management Facility, review facility specifications and design concepts, check analyses and make suggestions. A co-technologist for the Two-Phase Flow Facility will be provided at a later date.

W82-70305 **506-63-57**
Lyndon B. Johnson Space Center, Houston, Tex.
ELECTROMECHANICAL ACTUATOR TECHNOLOGY DEVELOPMENT
J. T. Edge 713-483-2392

This task extends electromechanical actuator (EMA) technology developed at the Johnson Space Center to include the evaluation of state of the art concepts and devices for the purpose of improving efficiency, specific weight, reliability, etc. This effort will focus on motor winding/power switch configurations and power conversion techniques (mechanical impedance matching or traction transmission). The principle deliverables will be laboratory test hardware and reports of the results of the contractor's test program.

W82-70306 **506-63-59**
Marshall Space Flight Center, Huntsville, Ala.
TRANSPORTATION SYSTEMS TECHNOLOGY DEVELOPMENT
Leon J. Hastings 205-453-3625
(906-63-13)

An analytical/experimental assessment of thermodynamic, fluid mechanic, and heat transfer interactions between various components/subsystems within a liquid hydrogen management system for orbital propulsion will be performed. A large scale test article containing all the basic elements representative of an orbital transfer vehicle propellant management system will be used. The results obtained will provide design guidance for orbital transfer vehicles/supporting orbital experiments, and normal gravity data for comparison with low gravity results. In addition, component/subsystem technologies involved in development of reusable cryogenic insulations will be pursued. Technology items/areas to be developed are: aluminized multilayer insulation reusability, purge bag simplification, insulations

compatible with Shuttle payload bay, and nondestructive insulation inspection techniques. A combination of in-house and contracted efforts will address these reusable insulation technology areas.

Space Systems Technology Programs

Space Systems Studies

W82-70307 **540-04-10**
National Aeronautics and Space Administration, Washington, D.C.
SPACE SYSTEMS AND PLANNING ANALYSIS
Stanley R. Sadin 202-755-2406

The objective of this RTOP is to provide space program planning studies in support of OAST space technology program requirements, assessments, planning and advocacy. The studies are intended to provide an analytical basis for planning activities in space R&T. Areas of work will include technology status and trends assessments; mission concepts and systems; long-range planning activities; program technology needs, requirements and opportunities. The major focus of this activity is the NASA Space Systems' Technology Model, including its completion and maintenance.

Information Systems Technology

W82-70308 **541-02-12**
Lewis Research Center, Cleveland, Ohio.
SATELLITE COMMUNICATIONS TECHNOLOGY
R. E. Alexovich 216-433-4000
(506-61-32; 506-54-42; 650-60-20; 650-60-21; 650-60-22)

The objective is to provide through research, design, and experimental tests the components, subsystems, and enabling technology required to support OSTA's program in satellite communications systems. To achieve this objective, advanced research and development programs will be conducted to identify, produce, and demonstrate critical components, techniques, and subsystems required for complete communications systems. Principal emphasis will be directed toward spacecraft microwave electron beam amplifiers with increased power output, efficiency, and high frequency capability; multifrequency, multibeam antennas providing increased frequency reuse; and solid state materials and component technology for high frequency spacecraft applications, such as switching, power conditioning, and beam forming.

W82-70309 **541-02-15**
Jet Propulsion Laboratory, Pasadena, Calif.
EARTH SATELLITE COMMUNICATION ANTENNA DEVELOPMENT
W. A. Imbriale 213-354-5172
(643-10-01)

The objective of this RTOP is to develop the RF technology required for the implementation of multiple beam communication satellite antennas. Particular emphasis is placed on the development of antenna feeds and the associated electronics for the generation of contiguous multiple beam applications such as that required by the land mobile satellite service (LMSS). The LMSS is a key element of the NASA 'Narrowband' communication program. It is anticipated that a large, multiple beam antenna system for this application will require technology readiness by the mid 80's. Through the development of generic and specific multibeam antenna technologies, this RTOP will help ensure the LMSS technology readiness as well as to provide fundamental antenna technology for other applications. Specific areas of investigation will include: RF antenna configurations, feed array designs, beam forming networks, large antenna measurement techniques, linear power amplifier designs, and conceptual designs of mobile vehicle antennas. Specific objectives for FY-82 will be to: (1) perform single vs multiple aperture trade-offs with a specific selection made; (2) develop reflector optics designs; (3) develop an effective feed element to meet both electrical and mechanical requirements; (4) study the possibility of active phase control and integrate recommendations into beam forming network (BFN) design; (5) develop BFN concept and components required; (6) develop power amplifier concept; and (7) investigate mobile vehicle antenna designs.

Spacecraft Systems Technology

W82-70310 **542-03-01**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF A SHUTTLE FLIGHT EXPERIMENT: DROP DYNAMICS MODULE
T. G. Wang 213-354-6331

The principal objective of this RTOP is to design, fabricate, and test an acoustic positioning and manipulation module for Spacelab and to utilize it to perform the experiment 'Dynamics of Rotating and Oscillating Drops' as part of the NASA Physics and Chemistry in Space Program on an early Shuttle/Spacelab mission, and will be available for Spacelab flights thereafter. This acoustic positioning and manipulation module will allow us to utilize the unique zero-g environment provided by a Shuttle/Spacelab flight to perform drop dynamics experiments that are impossible to perform in a gravitational field. Examples are: (1) study experimentally the problems first proposed by Newton of equilibrium figures and the bifurcation processes of a rotating spheroid and (2) understand the fission and fusion processes in drops that are also applicable to meteorology and nuclear physics. The scope of this work is threefold: first, to determine the maximum capability of this facility within the constraints of money and schedule through consultation with the scientific community and investigators; second, to fabricate a flight unit; and third, to perform the experiment 'Dynamics of Rotating and Oscillating Drops' as part of the NASA Physics and Chemistry in Space Program. The scientific community will be invited to participate in experiments informally through international symposia and colloquia. Some scientists will participate with JPL as science associates and consultants.

W82-70311 **542-03-04**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE OPERATIONAL FLIGHT TEST OF A LARGE SOLAR ARRAY
Henry Hill 205-453-3423
(506-34-19; 506-62-69)

The objective of this RTOP is to provide overall demonstration of the availability of advanced solar array technology by flight testing the Solar Electric Propulsion (SEP) Solar Array as an experiment on Shuttle. Demonstrating that the array will deploy and retract in a space environment and establishing its dynamic characteristics are objectives which are particularly important. The approach consists of four basic steps as follows: (1) define, through study and analysis, the requirements, criteria and conceptual design for the solar array experiment system (completed FY-77); (2) perform a detailed design, build, and test the flight array experiment; (3) install and fly the solar array experiment on Shuttle; and (4) evaluate flight results after return to Earth.

W82-70312 **542-03-13**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACELAB 2 SUPERFLUID HELIUM EXPERIMENT
C. Mohl 213-354-3388

An experiment to investigate the properties of superfluid helium in zero gravity was planned for flight on Spacelab 2 in early 1983, and now is scheduled for flight in November 1984. The experiment will determine the mechanical and thermal properties of superfluid helium in sufficient detail to enable the design of high performance, space qualified superfluid cryogen systems. A companion experiment will study the properties of low velocity capillary waves in thin films of superfluid helium. These waves cannot be observed in the Earth's gravity. Their study will increase scientific understanding of the interaction of normal and superfluid helium. The experiment will consist of an instrumented cryostat, an experiment package mounted inside

the cryostat, and an electronics control and data processing electronics package. It will be mounted on a Spacelab pallet, and will interface with the Spacelab Command and Data Management System. Interactive control with experiments on the ground will permit optimization of scientific results by real-time modification of experimental conditions and parameters.

W82-70313 **542-03-14**
Langley Research Center, Hampton, Va.
FILE FLIGHT EXPERIMENT ANALYSIS AND SUPPORT
W. E. Sivertson 804-827-3666
(506-18-23; 750-02-23; 506-61-73)

The objective of this RTOP effort is to support FILE flight experiments and the advancement of feature classification and cloud detection technology. Data processing techniques will be developed, evaluated, and used to process and analyze advanced feature classification and cloud detection data and imagery. Experimental FILE instrumentation parameters will be assessed relative to in situ flight performance. Also, co-principal investigator participation in FILE I/OSTA-1 and FILE II/A.C. flight operations and data collection will be included. FILE flight data will be analyzed to evaluate image scene classification relative to vegetation, bare earth, water, clouds, snow, and ice. Classification will be based on selected radiance ratios from spectral signature data in the 0.65, 0.85, 1.23, and 1.55 micron bands. Results from this effort will focus on providing new knowledge required for developing autonomous cloud detection, pointing, and tracking instruments for future missions. In-house FILE image processing techniques will be developed. Existing LaRC computer and color image display systems will be used to analyze data and generate color enhanced images. Classification algorithms will be developed and in-house statistical evaluations will be conducted to assess performance.

W82-70314 **542-03-20**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE CALIBRATION OF SOLAR CELLS
L. B. Sidwell 213-354-5489
(506-55-45)

The objective of this RTOP is to take advantage of the space environment of the Space Transportation System (STS) missions to correlate solar cell calibration data with those obtained from a balloon flight. The STS program will provide the opportunity to validate existing calibration procedures and to determine the most effective way of accomplishing solar cell calibrations. During FY-82, support will be provided to close out any action items resulting from the Final Design and Operation Review with the Marshall Space Flight Center. Candidate test solar cells will be selected and installed on the Solar Cell Calibration Facility. Level IX integration will be supported at Kennedy Space Center. Preintegration and Flight Readiness Reviews will be supported and any action items resulting from these and/or other reviews will be closed out prior to launch (scheduled for December FY-83).

W82-70315 **542-03-27**
Marshall Space Flight Center, Huntsville, Ala.
TRIBOLOGICAL EXPERIMENTS IN ZERO GRAVITY
R. L. Gause 205-453-1500

The experiment, 'Tribological Studies of Fluid Lubricated Journal Bearings in Zero Gravity,' will compare in a zero gravity environment the hydrodynamic films formed in journal bearings by conventional smooth bore bearings versus a three-lobed bearing design. In addition, the effect of centrifugal loading on these lubrication systems will be investigated. The experiment entitled, 'Wetting, Spreading, and Operating Characteristics of Bearing Lubricants in a Zero Gravity Environment,' will measure the spreading rates of lubricants in a zero gravity environment and determine the extent to which lubricant wettability is affected by this environment. In order to study the tribology of journal bearings in zero gravity, transparent journal bearings will be fabricated for both conventional and experimental designs. Plans call for photography of these bearings operating in zero gravity. The behavioral characteristics of lubricants will be determined by photography of selected-surface combinations and telemetered dynamic behavior of the journals.

W82-70316 **542-04-13**
Langley Research Center, Hampton, Va.
LONG DURATION EXPOSURE FACILITY
Leo P. Daspit, Jr. 804-827-3704

The broad LDEF Project objectives are the following: (1) to develop the Long Duration Exposure Facility (LDEF); (2) to develop and perform a first set of experiments on the LDEF; and (3) to broaden the operational STS user community. The LDEF, a shuttle transported, reusable, unmanned, low cost free flying structure on which many different experiments can be mounted, will be developed and manufactured in-house at Langley. The experiments, many of which are completely passive with active data measurements being made in the laboratory after recovery, will be solicited from all NASA Centers, other government agencies, industry, and foreign countries. The STS user community will be broadened by the LDEF providing a unique, simple, low cost approach to perform large numbers of needed long duration technology and science experiments. The establishment of a continuing program to provide for LDEF reflights after the first LDEF mission with the operational STS is a part of this RTOP. The implementation of the established follow-on program is not.

W82-70317 **542-05-12**
Lewis Research Center, Cleveland, Ohio.
FLIGHT TEST OF AN ION AUXILIARY PROPULSION SYSTEM (IAPS)
James F. DePauw 216-433-4000

A major goal of the OAST-LeRC electric propulsion effort is to achieve technology readiness and user acceptance of a high performance, long life mercury ion auxiliary propulsion system for use in the 1980's. The approach is to conduct a space flight test of an ion auxiliary propulsion system operated for time duration and duty cycle representative of potential operational missions. The flight system uses two 8-cm diameter mercury ion thruster operating at one millipound thrust level. The experiment will be flown aboard the USAF Space Test Project P80-1 (Teal Ruby) spacecraft. Also a ground test program to provide data on system performance and interfaces and a principal investigator function to technically guide the program and interact with potential users are included.

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS

Environmental Observations Applied Research and Data Analysis

W82-70318 **146-10-03**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE RESEARCH
Albert Arking 301-344-7208
(146-10-02; 146-10-04; 146-10-05; 146-10-06)

The purpose of this research is to conduct a broad base research program in support of the NASA Climate Program, including data base development, special studies of climate processes, climate modeling and analysis, and climate observing system development. The approach will be to: (1) publish 4-year atlas of sea ice concentration for Antarctic region and continue development of Nimbus 6 earth radiation budget data set development; (2) continue analysis of data from cloud radiation experiment, including CCOPE, and continue at modest level studies of air-sea interactions, cryospheric and boundary layer processes, and solar climate relationships; (3) analyze climate data sets to extract information on climate processes and estimate spatial and temporal variability; continue climate sensitivity, predictability, and diagnostic studies with GLAS GCM and with SDM's; develop coupled atmosphere-ocean model and improved methods of parameterization of climate processes; (4) continue efforts to develop concepts for a climate observing system with emphasis on precipitation; continue solar monitoring experiment. This RTOP supports the NASA Climate Program which in turn contributes to the National Climate Program.

W82-70319 **146-10-04**
Ames Research Center, Moffett Field, Calif.
AEROSOL CLIMATIC EFFECTS SPECIAL STUDY
J. B. Pollack 415-965-5530

A coordinated set of theoretical, laboratory, and field investigations of the chemistry and radiative properties of natural (e.g., volcanic) and man-made atmospheric aerosol particles are conducted in order to assess their impact on regional and global climate. The field investigations are intended to provide complementary information on aerosols to that being obtained from spacecraft platforms (e.g., SAM II and SAGE) so as to insure that a comprehensive set of aerosol properties are gathered for climate analyses. The theoretical and laboratory tasks are directed at interpreting and utilizing the aerosol data sets to perform the desired climate assessments. The centerpiece of the field investigations is a set of coordinated aerosol measurements, which are flown together on an appropriate aircraft platform (e.g., U-2). When possible, these flights are conducted in conjunction with spacecraft and other airborne aerosol measurements. Information is obtained on both the aerosol formation mechanisms and on their radiative properties so as to enable the development of a predictive capability as well as a determination of the present climatic effects of aerosols. Both theoretical modeling and laboratory studies are used to further define the mechanisms of aerosol formation, to provide hypotheses that can be tested by the field investigations, and to provide, ultimately, the predictive tools. Theoretical investigations involving radiative transfer, dynamics, and aerosol formation are utilized for making the climatic assessments.

W82-70320 **146-10-05**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING OF AIR-SEA FLUXES
W. Timothy Liu 213-354-2394

The capabilities of satellite-borne instruments in measuring parameters related to momentum and latent heat fluxes are to be examined and parameterization models to estimate these fluxes from satellite measurements are to be developed. The approach will be: (1) to assess the capabilities of Seasat instruments in measuring surface stress and flux-related parameters by comparing time and spatial variations; (2) to collect and organize surface marine and upper air data from National Climatic Center and the boundary layer measurements from recent experiments such as AMTEX, JASIN, and STREX; (3) to develop an elementary boundary layer parameterization model to estimate latent heat flux from satellite measurement by a semi-empirical approach using data collected; (4) define an optimum set of satellite measurements and their accuracies required by the model; and (5) using upper air data collected to study the vertical profile of humidity of the marine atmosphere and re-evaluate the capability of measuring boundary layer humidity from space in light of model requirements.

W82-70321 **146-10-06**
Langley Research Center, Hampton, Va.
RADIATION BUDGET AND AEROSOL STUDIES
James L. Raper 804-827-3431
(146-10-03; 146-10-02; 146-10-04)

Objectives are to develop improved satellite based monitoring of the Earth's radiation budget (ERB) and to conduct studies of atmospheric aerosols using ground based lidar techniques. The following approach will be used: (1) develop and validate models including comparisons with satellite and ground based measurements; (2) analyze Nimbus 6 and 7 ERB and NOAA scanning radiometer data to define large/small scale Earth radiation variations over space and time; (3) complete comparison of upwelling measurements obtained from HIRS, AVHR radiometer, and Nimbus 7 ERB with measurements from NOAA's ground network; (4) continue instrument studies in conjunction with VPI instrument model development, improve calibration sources experimentally, continue to optimize mirror attentuation mosaic for Earth viewing sensors; (5) continue to develop data base for scientific investigations; focus LaRC program on research areas identified by the science community through international contacts; coordination and continuation of the FY-81 seminar series; (6) continue 48-inch Lidar program to obtain aerosol measurements; (7) analyze Nimbus 6 ERB non-scanner data by comparing improved test results with GSFC orbital validation effort; (8) continue to analyze GOES data for developing efficient techniques for extracting cloud information; (9) continue study of volcanic eruption/climatic effects through integrating flights of opportunity through active volcanoes by five universities; (10) study local effects of broken clouds on radiation through satellite and ground based measurements.

W82-70322 **146-20-08**
Jet Propulsion Laboratory, Pasadena, Calif.
KINETICS STUDIES OF TROPOSPHERIC IMPORTANCE
Robert T. Watson 213-354-2231

A program of laboratory studies will be conducted to measure key rate constants for reactions of hydroperoxyl (HO2), methylperoxy (CH3O2) and iodine oxide (IO) radicals. The goal of this program is to improve the kinetics data base for reactions of these radicals so that model calculations of tropospheric photochemistry can be carried out with greater accuracy. Emphasis will be placed on the measurement of primary rate constants and the detailed reaction mechanisms. The experimental approach is to utilize a state-of-the-art long pathlength flash photolysis-ultraviolet absorption apparatus.

W82-70323 **146-20-08**
Langley Research Center, Hampton, Va.
MODELING OF TROPOSPHERIC POLLUTION, CHEMISTRY, AND TRANSPORT
John P. Mugler 804-827-2861

The objective of this RTOP is to conduct theoretical studies aimed at a more complete understanding of the chemical and transport processes in the global troposphere. The approach for achieving this objective consists of developing, validating, and applying dynamical and photochemical models to describe the processes that govern the budgets of key tropospheric trace species.

W82-70324 **146-20-08**
Goddard Space Flight Center, Greenbelt, Md.
APPLICATION OF REMOTE MEASUREMENT TECHNIQUES TO TROPOSPHERIC POLLUTION MONITORING
R. W. Stewart 301-344-8895
(146-20-10)

The objectives are to: (1) develop an understanding of tropospheric environmental problems that may be amenable to solution through the use of remotely sensed data; (2) develop, evaluate, and demonstrate remote sensing concepts for observing the nature and distribution of tropospheric pollution; and (3) demonstrate the application of remote sensing technology to the specific problem of assessing the impact of urbanization and industrialization on global, regional, and urban air quality. The development of global tropospheric models for calculation of tropospheric trace species concentrations will continue. Improved description of physical processes in the context of one and two dimensionsal models will be emphasized. This RTOP supports the following end objectives: (1) environment management and (2) technology transfer.

W82-70325 **146-20-08**
Goddard Inst. for Space Studies, New York.
GLOBAL TROPOSPHERIC MODELING OF TRACE GAS DISTRIBUTIONS
James Hansen 212-678-5593

The objectives of this RTOP are to contribute toward understanding the global budgets of the primary trace species and man's potential impact on the trace gas abundances and to determine the measurement requirements and sampling strategies for the tropospheric air quality program. The following approach will be used: three dimensional studies of trace gas distributions in cooperation with McElroy (Harvard Univ.), and employ a progressive series of studies of trace gases such as freons.

W82-70326 **146-20-10**
Langley Research Center, Hampton, Va.
APPLICATION OF REMOTE MEASUREMENT TECHNIQUES TO TROPOSPHERIC POLLUTION MONITORING
John P. Mugler 804-827-2861
(146-20-08)

The objective of the RTOP is to develop a basic understanding of those environmental problems associated with the global troposphere through a coordinated program of atmospheric modeling and measurements from satellite, aircraft, and ground based platforms. Remote sensing concepts for observing the nature and distribution of tropospheric pollution will be developed, evaluated, and demonstrated and the application of remote sensing technology to the specific problem of global and regional air quality will be demonstrated. The approach for achieving the objectives will consist of a coordinated program in modeling, instrument/technique development, laboratory studies, and field measurements. Additional tropospheric modeling studies are being conducted under RTOP 146-20-08.

W82-70327 **146-20-10**
Ames Research Center, Moffett Field, Calif.
TROPOSPHERIC AIR QUALITY - TECHNOLOGY DEVELOPMENT
W. A. Page 415-965-5404
(146-10-14; 147-10-03)

The broad research objective is to characterize tropospheric chemistry with a view toward determining impacts on the many aspects of environment quality relevant to human health, agriculture, climate, and weather. Present emphasis of this RTOP is to develop the needed airborne instrumentation systems capable of measuring the important tropospheric trace species such as OH, SOx, NOx, CO, and aerosols. For proper interpretation of field measurements all relevant meteorological parameters must also be well characterized. Program goals are described in NASA SP 1062. The plan is to first provide technology development of the needed instrumentation before performing extended field measurements. Developments for both low altitude and medium altitude (upper troposphere) aircraft will be stressed.

W82-70328 **146-20-10**
Goddard Space Flight Center, Greenbelt, Md.
SATELLITE MONITORING OF AIR POLLUTION
Robert S. Fraser 301-344-9008
(146-10-03; 146-20-08)

Satellite radiances are to be used to determine the aerosol optical thickness, aerosol mass, and visibility during dense air pollution episodes on regional and continental scales. Techniques for using high-spatial resolution satellite radiances will be developed. The global aerosol characteristics will be monitored using satellites and tropospheric concentration of OH and O3 will be measured. The GOES VISSR radiances will be used in conjunction with the AOIPS. An algorithm will relate the VISSR changes in radiance with aerosol optical thickness and mass, and also visibility. In order to increase the accuracy of the aerosol optical thickness, both theoretical and experimental studies of high-spatial resolution observations (LANDSAT) will be made. An aircraft borne lidar is being developed to measure the concentration of OH and O3.

W82-70329 **146-30-02**
Marshall Space Flight Center, Huntsville, Ala.
METEOROLOGICAL SATELLITE DATA APPLICATIONS
W. W. Vaughan 205-453-3100

The objective is to contribute to the NASA Global Weather Research Program objectives by performing diagnostic and theoretical studies of global scale atmospheric systems to: (1) develop new and improved spaceborne atmospheric sensing techniques; (2) develop new techniques to extract information from and more fully utilize existing and planned spaceborne atmospheric sensing systems; and (3) contribute to the development of our understanding of global weather processes. The approach will be to: continue detailed diagnostic studies with satellite and ground based data sets guided by theoretical studies to understand the role of latent heat release in the dynamics of cyclones, examine global weather processes to gain improved understanding of the scale of motion, and develop techniques for including satellite data in diagnostic procedures.

W82-70330 **146-30-02**
Goddard Space Flight Center, Greenbelt, Md.
METEOROLOGICAL SATELLITE DATA APPLICATIONS
Ernest A. Neil 301-344-6291
(146-10-02; 146-50-02)

The objectives are to: exploit the capabilities of remote sensing in understanding the dynamic and thermodynamic processes which govern the motions and state of the atmosphere and utilize remote sensing capabilities to improve the accuracy and range of large-scale numerical weather predictions. The approach will be to: develop improved techniques for extracting information from satellite data; improve capability of analysis and forecasting models to assimilate asynoptic satellite data; develop improved models which make full use of meteorological data provided by satellites; and conduct tests of satellite data impacts on forecasts and forecast skill. The RTOP supports the Global Weather Research Program. This program, in turn, supports the end objectives of increasing our understanding of atmospheric processes and improving our ability to forecast the large scale behavior of the atmosphere.

W82-70331 **146-30-02**
Jet Propulsion Laboratory, Pasadena, Calif.
GLOBAL WEATHER RESEARCH - NUMERICAL ANALYSIS OF REMOTE SENSING DATA
Moustafa T. Chahine 213-354-2433

The main objective of the proposed investigation is to develop rapid retrieval algorithms for accurate interpretation of remote sounding radiance data measured by the various NASA and NOAA weather satellites. The components of the retrieval algorithms will consist of individual numerical methods dealing with: (1) application of analytical techniques to separate the effects of clouds from the radiance data measured in the presence of partial cloud covers; this technique uses multispectral observations over adjacent fields of view made in the 4.3 microns, 15 micron and microwave parts of the spectrum; (2) development of a three dimensional quality control approach to filter out spurious temperature profiles, using the residuals of the relaxation solution and the degree of cloudiness as filtering criteria; (3) adaptation of the resulting temperature profiles to the requirements of the GLAS-GCM to demonstrate the impact of remote sounding data on weather forecasting; (4) retrieval of accurate sea-surface temperature using the 3.7 micron window to recover the skin surface temperature at night and perhaps during daytime observations; (5) derivation of three dimensional global maps of the distribution of the amounts and heights of clouds from infrared HIRS and VTPR data using special numerical minimization techniques; (6) improving the accuracy of computed atmospheric transmission functions needed for interpretation, using spectral data measured by the JPL high speed interferometers and (7) investigating an approach to derive air sea surface temperature differences at the surface, using data from the HIRS 2 instrument. The results could be applied to parameterize the planetary boundary layer of the GLAS-GCM at GSFC.

W82-70332 **146-30-03**
Langley Research Center, Hampton, Va.
METEOROLOGICAL LIDAR DEVELOPMENT
E. V. Browell 804-827-2576

The objective of this RTOP is to develop lidar techniques for remote measurements of water vapor and temperature profiles in the lower atmosphere. This program is divided into two activities. In the ongoing program, evaluation of the airborne DIAL system for making water vapor profile measurements in the troposphere will be completed. Data will be acquired in various regions of the troposphere and analyzed to provide insight into a broad range of atmospheric processes. An assessment will be made of the potential for applying the airborne DIAL system to investigation of various atmospheric processes. The objective of the proposed new research is to conduct a theoretical and experimental investigation of a three frequency DIAL technique for the simultaneous measurement of temperature and humidity profiles using water vapor absorption lines near 720 nm. An

experimental evaluation of this lidar technique will be conducted from the ground using a modified airborne DIAL system. An assessment of this technique for airborne and spaceborne applications will also be made.

W82-70333 **146-30-05**
Marshall Space Flight Center, Huntsville, Ala.
METEOROLOGICAL OBSERVING SYSTEM DEVELOPMENT
R. G. Eudy 205-453-0514

The objective is to contribute to the NASA Global Weather Research Program by performing fundamental studies aimed at improving our ability to measure synoptic-scale atmospheric wind flow on a global basis. Utilizing the talents of university and private contractor groups plus the MSFC inhouse talents and laboratory capabilities, specific research activities as described in the tasks of this RTOP will be accomplished.

W82-70334 **146-30-05**
Goddard Space Flight Center, Greenbelt, Md.
METEOROLOGICAL OBSERVING SYSTEM DEVELOPMENT
S. H. Melfi 301-344-6348
(146-30-02)

The objectives are to: develop new and improved spaceborne remote sensing systems in support of the NASA Global Weather Program and develop improved processing and retrieval techniques to provide for more accurate understanding of processes which influence the state and behavior of the atmosphere. Theory, laboratory measurements, and field experiments will be used to define, develop, and evaluate new and improved remote sensing techniques to observe profiles of atmospheric temperature, moisture, pressure, precipitation, surface properties, and atmospheric radiative properties. Infrared, visible, and microwave techniques for meteorological parameter retrieval will be studied in both active and passive modes. Evaluation, in cooperation with other scientists will be performed to assess improvement in weather forecasting.

W82-70335 **146-30-05**
Jet Propulsion Laboratory, Pasadena, Calif.
GLOBAL WEATHER RESEARCH - MICROWAVE PRESSURE SOUNDER (MPS)
Dennis A. Flower 213-354-4151

This RTOP supports the second phase of the MPS research program, the objective of which is to develop an instrument for the remote measurement of atmospheric pressure at the Earth's surface. Surface pressure is an important meteorological parameter but no method at present exists for its remote measurement. Extensive design studies have shown that differential absorption measurements in the wings of the 60 GHz oxygen absorption band are potentially capable of providing surface pressure observations with the accuracy and coverage suited to applications in global weather research and operational weather forecasting. The specific objectives of this phase of the investigation are: verification of the pressure measuring concept; characterization of the performance of an aircraft version of the MPS; a satellite instrument definition study; and the advanced development of critical components. The approach will be to use the results from an initial series of CV-990 test flights, with the MPS aircraft instrument now being fabricated, to verify theoretical relationships between the measured millimeter-wave absorption of the atmosphere and its meteorological parameters. A series of CV-990 test flights in a range of atmospheric types will be used to fully characterize the performance of the MPS instrumentation. Results from these experiments will be applied to previously developed optimization procedures for selecting the operating frequencies of a satellite MPS. A hardware design of this instrument will be produced together with flight experiment plans for testing, spacecraft integration, data analysis, management and cost. A special study of the antenna design will be undertaken. Development work will be initiated on the combination of IMPATT diodes in a single device to provide millimeter-wave oscillators with an output power of about 2W.

W82-70336 **146-30-06**
Marshall Space Flight Center, Huntsville, Ala.
THEORETICAL STUDIES OF ATMOSPHERIC PROCESSES
W. W. Vaughan 205-453-3100

The objectives are: to contribute to the NASA Global Weather Research Program by performing fundamental studies aimed at improving our understanding of large-scale atmospheric dynamics and to perform studies for the scientific design and interpretation of spherical laboratory models of large scale geophysical flows. These spherical models must be operated in a low gravity environment since the radial dielectric body force used to simulate gravity is weak. Two models are being prepared for Spacelab flights. The Geophysical Fluid Flow Cell (GFFC) is concerned with convective instability in vertically unstable atmospheres, and the Atmospheric General Circulation Experiment (AGCE) is concerned with baroclinic instability in vertically stable atmospheres.

W82-70337 **146-40-01**
Goddard Space Flight Center, Greenbelt, Md.
OCEANIC RESEARCH SUPPORT ACTIVITIES
D. B. Rao 301-344-4718

The objective is to provide support for a variety of oceanic and ice research activities which are important to the agency's program and will contribute to particular aspects of the program as they evolve. Among these activities are studies of precision orbit determination for ocean circulation topography research, warm water mass formation, eddies, sea ice, and the stability of tropical flows. Approaches to the variety of problems include the application of Goddard capabilities to the study of precision orbit determination and modeling problems, as well as the involving of leading researchers at institutions such as the Woods Hole Oceanographic Institution, Harvard University, and the Polar Science Center through a vigorous program of scientific seminars and cooperative research activities. The RTOP supports the Oceans, Ice and Climate Programs and the end objectives of understanding, predicting, and managing the environment. Expected results include improved estimates of TOPEX orbit determination capabilities, and knowledge of warm water mass formation processes, eddy dynamics, sea ice characteristics, and the stability of tropical flows.

W82-70338 **146-40-01**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEANIC PROCESSES BRANCH PROGRAM SUPPORT
Patrick J. Rygh 213-354-7240

The objective of this RTOP is to provide the Oceanic Processes Branch, NASA Headquarters, with limited program management capability during FY-82. Numerous scientific and programmatic questions arise during the normal operations of any program office; this is particularly true for the Oceanic Processes Branch due to the diversity of subject material and current staffing levels. JPL proposes under this RTOP to provide program support, (i.e., workshops, publications, etc.) as deemed necessary by the Ocean Processes Branch. JPL also proposes, under this RTOP to provide the services of a member of the JPL technical staff as a detailee working under the direction of the Chief, Oceanic Processes Branch.

W82-70339 **146-40-03**
Jet Propulsion Laboratory, Pasadena, Calif.
RADAR STUDIES OF THE SEA SURFACE
Robert H. Stewart 213-354-5079

Ocean surface currents may be observed indirectly from space using a radar (a delta-k radar) that measures the phase velocity of surface gravity waves. The observed phase velocity of surface gravity waves. The oberved phase velocity minus the theoretical velocity is directly related to the mean current averaged over a depth of roughly a tenth of the radar wavelength. The surface current can be produced by winds or by the gravity waves themselves. To evaluate the accuracy of the technique and to determine the relative importance of wind and wave induced currents, both of which are important to the development of future spaceborne systems, we have collected wind, wave, and radar data as part of the JASIN experiment. I propose to finish the analysis of these data in collaboration with colleagues at

Stanford University. The development of techniques for remotely measuring oceanic rainfall is hampered by a lack of accurate means for calibration. Rain gauges on ships are notoriously inaccurate, and shipborne radars are expensive and not sufficiently developed to yield accurate measurements. Noise produced by rain falling on the sea may offer a new method for calibrating rain rate. A graduate student working with me at the Scripps Institution of Oceanography, J. Nystuen, has surveyed the literature, and concludes that the technique is very promising. I propose to continue to supervise this work and to fund it through a subcontract to the Scripps Institution of Oceanography.

W82-70340 **146-40-04**
Jet Propulsion Laboratory, Pasadena, Calif.
MESOSCALE OCEAN DYNAMICS: SAR DETECTION OF OCEAN WAVES, SURFACE WIND, CURRENT BOUNDARIES, AND BOTTOM FEATURES
O. H. Shemdin 213-354-2447

The objectives are to complete investigation of the interactions of surface wind, waves, currents, and storm surge in MARSEN and to document in refereed journals the modulation of backscattered microwave signals by long ocean waves and the interaction between long waves and short waves in the ocean in relation to SAR. The approach will be to: continue to completion coordination of data analysis collected by MARSEN investigators; complete analysis of the data sets collected by JPL investigators on SAR, capillary waves, and surface wind stress; complete the model which describes modulation of short waves by long waves to use as input for determination of SAR system transfer function; and complete data analysis that demonstrates SAR capabilities for detecting surface wind, and current.

W82-70341 **146-40-04**
Goddard Space Flight Center, Greenbelt, Md.
MESO-SCALE EXPERIMENT ANALYSIS: OCEAN DYNAMICS
P. S. Schopf 301-344-9503

The objectives are: (1) to provide theoretical basis for and simulation experience with the inference of ocean circulation from remote sensing, the relationships between surface temperature and sea height variability in the tropics, and coupled ocean sea ice effects on the analysis of microwave images; and (2) to analyze existing altimeter data sets for the study of oceanic mesoscale variability. The approach will be to: analyze the 3.5 year GEOS-3 and 3-month SEASAT altimeter data; perform circulation model calculations for the N. Atlantic ocean and test and develop inverse, beta-spiral and ideal fluid techniques; perform upper ocean model simulation and diagnosis for the seasonal tropical Atlantic; and extend and couple the upper ocean and sea ice models. Eddy statistics, relation of tropical surface conditions to wind, understanding of remote links between surface observables, and improved ability of ocean diagnosis from space are expected. This RTOP supports the following major programs: (1) ocean circulation and (2) air sea interaction. These in turn support the following end objectives: (1) analysis of existing data, (2) assessment of the impact of SASS and altimeter data on forecast models, and (3) theoretical studies of the interaction of electromagnetic radiation and oceanic dynamical and physical processes.

W82-70342 **146-40-05**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN WAVE HEIGHT DETERMINATION WITH THE SYNTHETIC APERTURE RADAR
Atul Jain 213-354-6614

The objective of this work is to develop and demonstrate the capability of the SAR to provide measurements of ocean wave heights. The approach adopted to do this consists of: (1) obtaining radar images utilizing small sections of the total signal bandwidth, determining the normalized average product of intensities for such images as a function of frequency seperation of the bandwidths used, and measuring the rate at which this curve falls off; (2) understanding the relationship between the ocean surface and the image observed by the SAR and relating the total energy in the wave peak of the SAR image transform to the ocean wave height. In FY-81 we have completed studies establishing the proof of concept for these techniques. In FY-82 we will implement these techniques on an operational basis for SEASAT data, complete the work required to determine the analytical and physical relationships behind these concepts, and study the cheapest and fastest way to use the wave height measurement to obtain directional wave energy spectrum from the SAR.

W82-70343 **146-40-05**
Wallops Flight Center, Wallops Island, Va.
MICROSCALE OCEAN SURFACE DYNAMICS STUDY
N. E. Huang 804-824-3411
(146-40-13; 146-40-16)

The application of remote sensing techniques for oceanographic studies have great potential. But before the techniques can be fully established there is some crucial information about the ocean surface that we have to know. In this proposal we outline our approach to provide this information. The central theme and the main objective of our study is in establishing remote sensing techniques. The central problem in achieving this goal is the knowledge of the statistical properties of the ocean surface. But in order to know that, we have to know how the waves interact among themselves, how they evolve, and how they interact with wind and current. We also propose to study the importance of wave breaking and the dynamic consequence of the breaking phenomenon. Our approach to resolve these problems is by theoretical analysis and controlled laboratory experiments. Although we realize the importance of field work, due to the high cost we will only attempt small scale field tests along side our laboratory tests as a spot check.

W82-70344 **146-40-05**
Langley Research Center, Hampton, Va.
MICROSCALE OCEAN SURFACE DYNAMICS
W. L. Jones 804-827-3631
(146-40-06; 146-40-13)

The objectives are: (1) to provide a physically unambiguous interpretation and quantitative utilization of active microwave remote observations of ocean conditions, to assess the impact of same on relevant problems in oceanography, and to publish results in the referred literature; (2) to investigate (through theory and experiment) the interactions between the microscale ocean surface features and electromagnetic waves as detected by active microwave sensors such as scatterometers and imaging radars; and (3) to establish radar signatures of the ocean as a function of geophysical conditions and to develop data inversion algorithms for retrieval of information on ocean's dynamic characteristics and wind stress. For FY-82, this effort wll be primarily the completion of current research under this RTOP to include archival of data, documentation of data reduction and analysis software, and the reporting of results.

W82-70345 **146-40-05**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF AIR-SEA INTERACTION PHENOMENA
F. C. Jackson 301-344-5380

The overall objective of the research carried out under this RTOP is the improvement of our remote ocean sensing capability using microwave techniques. Attention focuses specifically on two problem areas: (1) the development of a microwave radar technique for measuring ocean wave directional spectral from satellites and (2) the improvement of passive radiometric techniques for satellite measurments of such air sea interaction parameters as sea surface temperature (SST) and surface wind speed. Research carried out to date indicates that global wave spectrum measurements are possible using rather simple scanning beam pulsed microwave radars. Validation of and refinement of the scanning beam approach is accomplished through aircraft flight experiments using the Goddard 13.9 GHz short pulse radar. A refinement of the scanning multichannel microwave radiometer (SMMR) ocean algorithm is sought. High quality surface observations and climatology are used to infer sensor problems and to derive better physical models. This RTOP supports major objectives in the Oceanic Processes and Weather and Climate Programs.

W82-70346 **146-40-06**
Langley Research Center, Hampton, Va.
MICROWAVE REMOTE SENSING FOR ICE PROCESSES RESEARCH
Calvin. T. Swift 804-827-3631

The prime objective of this work was to provide a physically unambiguous basis for the interpretation and quantative utilization of combined active and passive microwave remote sensing of sea ice characteristics and to report the results in the referred literature. To this end, the research will focus on the analysis of microwave data in hand from the NASA C-130 flights conducted during the winter of 1979. The orderly reduction and reporting of the Norwegian Sea, Beaufort Sea/Bering Sea, Greenland and Great Lakes Experiment will close out the activity.

W82-70347 **146-40-06**
Jet Propulsion Laboratory, Pasadena, Calif.
COUPLED ACTIVE/PASSIVE SEA ICE ANALYSES
Frank D. Carsey 213-354-2111

The purpose of this work is to improve the interpretation of active and passive microwave sea ice data taken from space by examining the use of one data set to resolve the limitation inherent in the other. The principal data sets are the SASS, SAR, SMMR, and altimeter from SEASAT; other data will come from the HCMM, NOAA, and LANDSAT programs and from aircraft experiments. Impetus for this study comes from the discovery in ESMR data for 1973 to 1976 of spatial variations in the emmissivity of multiyear ice of the artic. This variation produces an interpretation ambiguity, but may also indicate differences in ice character whose identification will be useful, for example, differences due to regionally different climate conditions over the recent past.

W82-70348 **146-40-07**
Goddard Space Flight Center, Greenbelt, Md.
OCEAN CIRCULATION TOPOGRAPHY
J. G. Marsh 301-344-5324

The objective is to provide a physically unambiguous basis for the interpretation of satellite altimeter observations of sea surface topography for application to the oceanographic problem of mapping large scale currents and mesoscale features and the extraction of tidal constituents. Existing GEOS-3 and Seasat altimeter and tracking data will be analyzed for the development of precision ephemerides and topography maps. The GEOS-3 (3.5 year) and Seasat (3 month) altimeter data sets form the data base to be used in these investigations. The ocean topography data will be developed from these data in order to derive information on ocean circulation processes. Techniques for precision ephermeris computation will be further developed and applied to laser and electron tracking data in order to provide an absolute orientation for the topography data with respect to a center of mass coordinate system. This RTOP supports the NASA Ocean Circulation Program. This program supports the end objective of developing a satellite borne capability for measuring ocean currents in order to increase our understanding of processes which control the mantle and atmospheric environments.

W82-70349 **146-40-07**
Jet Propulsion Laboratory, Pasadena, Calif.
GEOID MODELING AND BATHYMETRY FROM SEASAT ALTIMETER DATA
Timothy H. Dixon 213-354-4977

SEASAT altimeter data will be used to quantitatively describe the correlation between geoid anomalies at short to medium wavelength and bathymetry. The correlation function will be developed in several well surveyed regions in the north Pacific. This will initially involve comparison of two dimensional geoid and bathymetry data in the Fourier domain. Later, Kalman filtering techniques will be applied. Systematic variation between the form of the correlation function and geophysical parameters such as age or thickness of the lithosphere will be investigated. Nonsystematic variation due to geologic character of the crust will be considered. Once the form of the correlation function and its systemaic variation is known with some confidence, the derived filter will be applied to altimeter data in poorly surveyed regions of the south central . This will generate aproximations to real bathymetry and should prompt regions of bathymetry/geoid anomalies not previously known.

W82-70350 **146-40-08**
Goddard Space Flight Center, Greenbelt, Md.
MESOSCALE ICE DYNAMICS AND PROCESSES OBSERVATIONS
D. J. Cavalieri 301-344-6690
(146-10-03)

The objectives are to: (1) improve the physical basts for interpretation and quantitative utilization of passive microwave space observations for studies of sea ice dynamics and processes in the polar oceans; (2) improve and verify method for retrieving sea ice parameters from multichannel microwave remote sensors; and (3) validate and extend the utility of existing ice concentration data sets. Passive microwave data from Nimbus 5, 6, and 7 will be used with other imagery, in situ data, and ancillary remotely sensed data to study variations in space and time of observed microwave characteristics and derived geophysical parameters. Regional microwave characteristics will be identified and used to further improve parameter retrieval. Specific tasks will be addressed to the following problems: (1) describe and interpret the observed spatial and temporal variations of the microwave sea ice signatures including the summer fall transition from both single and multiple frequency data sets; (2) improve ice concentration accuracy (3) improve and verify methods for retrieving other ice parameters; and (4) validate both the ESMR-5 and SMMR sea ice algorithms. The RTOP supports Oceans Program and Climate Program and end objectives of understanding and managing the environment.

W82-70351 **146-40-08**
Jet Propulsion Laboratory, Pasadena, Calif.
CALIBRATION PROCEDURES AND STANDARDS FOR ACTIVE MICROWAVE REMOTE SENSORS
Daniel N. Held 213-354-7763

The objective of this RTOP is to develop and test, in conjunction with the OAST SAR Calibration Technology RTOP, procedures and standards for radiometrically calibrating and cross calibrating synthetic aperture radars (SAR) with other active microwave sensors including scatterometers and radar spectrometers. The initial effort has concentrated on performing a thorough literature search and consulting with colleagues in both the SAR, scatterometer, and radar spectrometer disciplines in order to ascertain the techniques which are currently being employed to calibrate each of these sensors. In addition we have analyzed and simulated the effects of system nonlinearities (which occur in optically correlated SAR data, and to a lesser extent in digitally correlated data) on the potential accuracy of the calibrations. Over the next two years we plan to develop specific techniques and standards for calibrating synthetic aperture radar imagery and aid in the implementation of these techniques on the JPL CV990 radar. Subsequently, we propose to sponsor a multi-sensor field trip to cross calibrate synthetic aperture radar(s), scatterometers, and radar spectrometers. As a minimum we expect the participation of the JPL L-band SAR, the JSC X- and C-band SARs, and JSC scatterometers (L-band to KU-band), and JPL's and the University of Kansas' radar spectrometers. It is anticipated that we will participate in the analysis of the data set to be collected by ESA using the Canadian CV 580 SAR and perhaps additional analysis of the SEASAT SAR data set.

W82-70352 **146-40-13**
Langley Research Center, Hampton, Va.
ADVANCED OCEAN SENSORS SYSTEMS DEVELOPMENT
Calvin T. Swift 804-827-3631

The overall objective of this work was to provide a physically unambiguous and accurate basis for the interpretation and quantative utilization of remote passive microwave sensors in studies of physical, biological, and geological oceanic processes. The prime geophysical parameters of interest are salinity and temperature in both the coastal zones and open ocean. The approach was to use Langley developed precision radiometer systems on board NASA and NOAA aircraft to collect data in collaboration with scientists affiliated with other government

agencies and reputable oceanographic institutions. To close out this activity, the VHF radiometer system development will be completed with flight testing and participation in a Warm Core Ring experiment for accuracy evaluation with sea truth. The completion of this work will include the analysis of the data and reporting the results in the refereed literature.

W82-70353 **146-40-13**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED EARTH ORBITER RADIO METRIC TECHNOLOGY DEVELOPMENT
W. G. Melbourne 213-354-5071

The objective of this RTOP is to perform a systems study of advanced radio metric technology for the accurate determination of the orbits of low altitude earth satellites. Future applications missions will require sub-decimeter accuracy in knowledge of satellite geocentric radial position. Current ground based radio tracking systems do not possess the requisite metric accuracy. Further, they are not adequately distributed to provide the level of coverage required for low earth orbiter missions. Laser ranging systems currently provide 5 to 10 cm measurement accuracies but coverage with the current set of laser systems will not be adequate for future missions. Augmentation of the number of laser tracking stations to ensure adequate coverage is one approach to support these missions. An alternative approach is the development and deployment of an all weather radio tracking network with the requisite metric accuracy to complement the existing laser stations. A systems study will be undertaken to define the functional characteristics of the critical system elements of a radio tracking network for low earth orbiters. A study output will be an estimate of the nonrecurring and recurring costs for implementation and operation of the network, a functional requirements document for spacecraft (S/C) and ground systems, and a plan to demonstrate the capabilities of the radiometric system. The study will conduct a comparative evaluation of the estimated accuracy and cost of the laser and radio metric systems. For costing purposes the network will be assumed to be a sub-net of the consolidated -DSN.

W82-70354 **146-40-13**
Wallops Flight Center, Wallops Island, Va.
ADVANCED OCEAN SENSOR SYSTEMS DEVELOPMENT
J. T. McGoogan 804-824-3411
(146-40-05)

The objectives are: (1) to provide a physically unambiguous basis for the interpretation and quantitative utilization of remote active microwave observations of oceanic conditions, to assess the impact of same on relevant problems in oceanography and to publish the results in the refered literature; (2) to further develop satellite altimetry techniques towards supporting future missions such as TOPEX and related follow-on missions; and (3) to develop an overall plan that will identify the key technology that must be advanced and studies that are needed to investigate the potential of new techniques and system improvements. More accuracy, easier calibration, longer life, more rapid coverage, new products (i.e., directional wave spectra, direct current motion measurements, etc.) and more reliable performance over ice and land will be emphasized. Requirements obtained from future mission plans will be used to establish those sensor changes that are most promising for future implementation. New concepts will be analyzed and modeled, new hardware developed and tested and supporting studies conducted as required to firmly establish new sensor capabilities. An overall error budget will be used to help establish priorities for system improvements.

W82-70355 **146-40-15**
Goddard Space Flight Center, Greenbelt, Md.
COASTAL AND ESTUARINE DYNAMIC PROCESSES RESEARCH
H. H. Kim 301-344-6465
(666-32-21)

The objective of this research is to observe ocean mesoscale features remotely and relate the observations to the dynamics and ocean biota of the study areas. Research efforts in FY-81 will primarily focus on analysis of field data collected in FY-81. Case studies to be analyzed include: (1) Georgia Bight Experiment (GABEX, 79-80), (2) South Atlantic Bight Experiment (SABEX-81), and (3) field data collected during the Space Shuttleborne/Ocean Color Experiment (STS-2/OCE) overflight of several test sites in September 1981. Remote sensor data along with cooperative field data will be used to describe the physical dynamics of the test sites and associated bioproductivity of the area. Increased validation is expected on the use of ocean colorimetric imagery in improved physical flow models of upwellings and other anomalies. Application of the imagery and development of a predictive method for determining marine bioproductivity are also proposed.

W82-70356 **146-40-15**
Langley Research Center, Hampton, Va.
COASTAL AND ESTUARINE DYNAMIC PROCESSES RESEARCH
E. B. Pritchard 804-827-3645

The objective of this research is to provide a scientific basis for the interpretation and use of remote sensing in studies of estuarine and coastal marine environments. Emphasis is on developing the unique capability of remote sensors to provide synoptic, mesoscale measurements to study biological, physical, and geochemical processes and their interrelationships. The following tasks will be completed: (1) analysis and reporting o interactive ship, aircraft, and satellite measurements collected in FY-1981 to elucidate the coupling between physical and biological oceanographic processes responsible for the high biological activity on Nantucket Shoals, (2) characterization of microflagellate isolates to determine whether a significant portion of this population has chloropyte-like characteristics; and (3) validation of a semi-analytic lidar Monte Carlo radiative transfer model with experimental results obtained by a laboratory lidar system.

W82-70357 **146-40-16**
Wallops Flight Center, Wallops Island, Va.
APPLICATION OF SURFACE CONTOUR RADAR TO OCEANOGRAPHIC STUDIES
E. J. Walsh 804-824-3411

The objectives are: to acquire, process, analyze, and publish SCR data sets which support the following goals: (1) establish in the oceanographic community the validity of the directional wave spectra produced by the SCR through comparison with in-situ sensors; (2) develop an ocean data base in support of the Wallops spectrum and Huang's analysis of significant slope versus the skewness of the sea surface height distribution; (3) determine the evolution of directional wave spectra under fetch-limited conditions; (4) study electromagnetic (EM) bias; (5) compare the directional wave spectra produced by the SCR with those produced by a SAR and a SLAR; and (6) generate the transfer function relating the backscattered power to angle of incidence, local slope, and azimuthal angle relative to the local wind. The unique capability of the SCR to produce two perfectly registered maps, one of topography and another of radar backscattered power will be utilized. These data will be processed in various ways to: measure oceanographic parameters directly and evaluate the ability of satellite systems to measure them remotely. Data which has already been acquired and additional data to be acquired in the coming year will be compared with in-situ sensors such as pitch and roll buoys, other remote sensors such as SLARs and SARs, and the results of simulations.

W82-70358 **146-40-16**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED LOCATION AND DATA COLLECTION SYSTEM
Charles E. Cote 301-344-8215
(146-30-05)

A detailed definition of a location and data collection system meeting requirements for low cost platforms and having sufficient capacity to meet ocean requirements projected for the next decade will be developed along with the technology for low cost buoy transmit terminals. Advanced system design studies will be continued to finalize performance and implementation for an ocean mission. Through consultation with the ocean research community it will be insured that the system meets anticipated growth requirements for global circulation studies. In support of short

and long term drifter experiments, techniques to reduce stringent specifications for carrier stability will be studied and tested with the Argos system. The RTOP supports the following major programs: (1) air-sea-interaction program; (2) ocean circulation program; (3) search and rescue program. The end objective is to reduce the cost of in-situ location measurements. A system design will be completed having the required capability to support global circulation requirements. Low cost buoy oscillator developments will permit near term applications with Argos while also supporting future goals.

W82-70359 **146-40-16**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN NAVIGATION
Srinivas N. Mohan 213-354-6721

This work unit is a continuation of the FY-81 ocean navigation system design effort, aimed at demonstration of navigation performance and operational support of research being conducted at the Scripps Institution of Oceanography using the NAVSTAR Global Positioning System. In addition to the demonstration and operational support; collection and reduction of navigation data; and, reduction of acoustic Doppler data in conjunction with the navigation data are planned.

W82-70360 **146-40-17**
Goddard Space Flight Center, Greenbelt, Md.
RESEARCH APPLICATIONS OF OCEAN DATA IN LARGE-SCALE FORECASTING MODELS
M. Halem 301-344-7482
(146-10-02; 146-30-02)

The objective is to provide theoretical support for the application of satellite observations of ocean-atmosphere interactions. The principal applications are: (1) the assimilation of surface wind and temperature data into numerical weather prediction (NWP) models and the determination of their impact on short term forecasts; (2) the prediction of upper ocean currents, temperatures, sea state, mixed layer depths, and upwelling zones; and (3) the interactions of the atmospheric and oceanic circulation systems on time scales of a month or more. This program specifically includes ocean modeling and is designed to support extended range forecasting and climate studies which depend on ocean-air interactions. Experience gained in extracting and utilizing meteorological information from satellite derived data over the past 6 years has provided Goddard Modeling and Simulation Facility (GMSF) with a unique capability. The Laboratory for Atmospheric Sciences (GLAS) general circulation model (GCM) has been a crucial component of this previous work. The above application of Seasat data requires a similar model for predicting the ocean-atmosphere interactions. Our plan cals for coupling the GCM with a model of the upper ocean circulation, as well as further development of ocean models. Expected results are: the assessment and improvement of techniques for the use of satellite data in short and medium range numerical weather prediction and ocean modeling; the enhancement of our ability to model the oceanic circulation and thermal structure; and the identification of oceanic features that influence climatic states.

W82-70361 **146-40-21**
Goddard Space Flight Center, Greenbelt, Md.
VERSATILE OCEAN COLOR RADIOMETER UTILIZING DETECTOR ARRAY TECHNOLOGY
W. L. Barnes 301-344-8117
(677-27-01)

Research in ocean color radiometry and ocean bioproductivity will be performed using the horizontal quantitative distribution of pigment concentration diffuse attenuation coefficient and other ocean parameters that lend themselves to remote sensing from space. An existing 512 X 32 element Si detector array will be used to develop a 32-channel imaging radiometer that will have 10 nm spectral widths in the range from 400 to 860 nm, a 26m footprint from 65 kft, and high signal to noise. The sensor will use an existing airborne data system. The RTOP supports the following major programs: ocean optics and MLA. These in turn support the following 'end' objectives: (1) ocean bioproductivity, (2) ocean dynamics; and (3) ocean color radiometry. High quality ocean color imagery are expected, that will serve as input to radiometric algorithms and thereby result in clarification of the utility of ocean color radiometry to address oceanic problems

W82-70362 **146-40-21**
Jet Propulsion Laboratory, Pasadena, Calif.
LIDAR AND ACOUSTICS APPLICATIONS TO OCEAN PRODUCTIVITY
Donald J. Collins 213-354-3473

The objective of this research is to develop on in situ instrumentation capable of examining the vertical structure of the phytoplankton and zooplankton communities in the ocean in order to provide a detailed description of the three dimensional structure of the ecological systems involved in ocean productivity. These measurements form one part of a long term effort to monitor the productivity of the world's oceans using oceanic LIDAR from aircraft and using satellite instrumentation to provide images on a global scale. These objectives will be achieved by: (1) participation in a long range planning effort for studies in ocean productivity; (2) development of an in situ LIDAR instrument capable of remote measurement of the fluorescence from Chlorophyll and other pigments, this unit will use the water Raman return as a measure of the optical properties of the water column, Brillouin scattering for the remote measurement of temperature; (3) development of a linearly frequency modulated sonar instrument capable of measuring the vertical distribution of zooplankton species in the euphotic zone; (4) development of a towed submersible that will provide a stable platform for the in situ instrumentation and that will provide physical oceanographic data and calibration data required for these measurements.

W82-70363 **146-40-21**
Wallops Flight Center, Wallops Island, Va.
APPLICATIONS OF LASER TECHNIQUES
Frank E. Hoge 804-824-3411

The scientific process and lidar instrumentation development and applications initiated in prior FY under proposal 'Diffuse Attenuation Coefficient Measurement Using Airborne Laser Induced Water Raman Backscatter' will continue. Airborne oceanographic lidar system improvements will be implemented: (1) add a second dye laser to yield an addition operating wavelength and (2) implement two wavelength depth resolved Mie scatter capability for chlorophyll measurement in airborne oceanographic lidar (AOL) complete with gated photomultiplier tube Fresnel surface reflection rejection. One of the prime reasons for this system capability is to potentially increase depth to which data can be taken. Two wavelength depth resolved Mie scatter data and integrated spectral fluorescence data will be acquired during airborne transects of a warm core rin (WCR). The research results of Dr. R. Zika (U. of Miami) and Dr. O. Zarfiriou (WHOI) will be assimilated and applied to the remote laser measurement of dissolved organics in sea water. The recent AOL fluorosensor data taken during the Nantucket Shoals Experiment will be assessed to determine the seawater fluorescence detection sensitivity. The depth resolved Raman data (422.6 nm laser excitation/493.5 nm backscatter) will be used to assess the utility of yielding the sum of the attenuation coefficients at these two wavelengths. The AOL results will be compared with the shipboard measurements of Dr. Paul Falkowski, (Brookhaven National Laboratory) operating in the Nantucket Shoals Experiment test region and Mr. Charles Yentsch (Bigelow Laboratory) who was operating in a region just south of the shoals. These data will allow comparison in clear water mass but more data is needed in more turbid waters to test the limit of the depth resolved technique.

W82-70364 **146-40-30**
Goddard Space Flight Center, Greenbelt, Md.
OCEAN SCIENCE AND SYSTEMS STUDIES
Charles F. Thienel 301-344-5221
(146-40-05; 146-40-16)

The objectives are: (1) to facilitate a comprehensive Oceans Research/Instrument Program in the areas of ocean circulation, ocean productivity, and air/sea interactions taking into account present requirements and current and planned complementary space systems and (2) to identify those measurements which

are still required to implement this program and evaluate the feasibility of systems that can provide those measurements, from the integration of existing instrument technology into presently available satellite systems through the development of new systems capable of providing the necessary end data products. This will be accomplished by: taking into account programs presently planned or in effect; conducting in-house, contracted, and peer group studies to develop the scientific requirements for the identified ocean measurement parameters; and performing tradeoff studies to determine the most cost effective implementation of present technology to obtain those measurements. Where the technology is not presently in hand, studies will be performed to evaluate the potential of new techniques as candidates for further development. A comprehensive Oceans Program will be defined which identifies currently unfilled science requirements and proposes the implementatio of existing technology to satisfy the immediate scientific needs while developing the systems required to provide data for the longer term unmet science requirements.

W82-70365 **146-50-02**
Goddard Space Flight Center, Greenbelt, Md.
SEVERE STORMS AND LOCAL WEATHER RESEARCH
J. Simpson 301-344-6923
(146-50-02)

The objectives are to: (1) utilize space observations to improve understanding, diagnosis, and predictability of severe atmospheric storms (tropical and mid-latitude); (2) develop analysis and interpretation techniques using data from satellites in combinatin with other sources; (3) adapt subsynoptic and storm scale numerical models to use satellite and conventinal data; (4) simulate impact of satellite measurements on severe storm analyses, predictions; (5) cooperate with NOAA and other user agencies on technology transfer and evaluation of new technology involving space observations; and (6) formulate requirements for future satellites to improve severe storm diganosis, warnings. The approach is to: (1) develop quantitative methods to utilize satellite data in predictive models, diagnostics, and nowcasting; (2) develop tests of the scientific accuracy and usefulness of VAS geosynchronous soundings; (3) conduct case studies utilizing AOIPS to synthesize data sets, often with model output, to improve physial undestanding and predictive capability; (4) obtain combined satellite, remote aircraft, and in situ data sets from participation in joint field programs; and (5) adapt numerical storm-scale, subsynoptic scale models to use satellite data in initialization, model improvement, and data interpretation. Other objectives include: more effective use of current and future space data in severe storm understanding, prediction, warnings; models simulations which are improved by utilizing combined satellite, and conventional data sets; and improved space diagnosis of thunderstorm and hurricane development, intensity, motion, and rainfall.

W82-70366 **146-50-02**
Marshall Space Flight Center, Huntsville, Ala.
SEVERE STORMS AND LOCAL WEATHER RESEARCH PROGRAM
W. W. Vaughan 205-453-3100

The objective is to contribute to the NASA Severe Storms and Local Weather Research Program by conducting applied research and development using space related techniques and observations that will increase the basic understanding of storms and local weather warnings. Utilizing the talents of university and private contractor groups, plus the MSFC in-house talents and laboratory capabilities, specific research activities as described in the tasks of this RTOP will be accomplished.

W82-70367 **146-60-01**
Goddard Space Flight Center, Greenbelt, Md.
OZONE DATA REDUCTIONS AND ANALYSIS AND SOLAR UV VARIABILITY
Donald F. Heath 301-344-6421

Objectives include: (1) analysis, interpretation, and assembly of atmospheric ozone and meteorological data and UV solar flux data for the investigation and determination of the natural variability of the middle atmosphere; (2) evaluation of climate processes in the middle atmosphere; (3) investigation of the sources of secular changes in atmospheric ozone, determination of trends, and identification of anthropogenic and solar related effects; and (4) to provide rocket support measurements of ozone to SME and Nimbus-7 programs. Through the use of harmonic and trend analysis techniques, long and short period variations of ozone are investigated on a global scale to investigate the mechanisms which determine the spatial and temporal variability of ozone. Ozone transport is evaluated from analysis of meteorological and ozone data. Rocket measurements with ROCOZ and chemiluminescent sondes are made to support SME and Nimbus-7. Other objectives includes: (1) determination of ozone trends and spatial and temporal variability 1970-1980 and middle atmosphere climate processes; (2) continuing support of satellite ozone and solar flux measurements with measurements from balloon and rocket systems of ozone and UV solar flux; and (3) determination of UV solar flux variability and mechanisms which can affect the regions of the middle atmosphere and below.

W82-70368 **146-60-01**
Langley Research Center, Hampton, Va.
STRATOSPHERIC MEASUREMENT PROGRAM ACTIVITIES
R. H. Tolson 804-827-2530
(147-40-01)

The overall objective is to develop, evaluate, and apply remote sensing technology and measurements to the environmental monitoring of the stratosphere. Specifically, work will focus on developing and evaluating solar extinction radiometry technology for stratospheric measurements; on developing data interpretation techniques for satellite sensors; on developing techniques for correlating ground, aircraft, rocket, balloon, and satellite data; on developing empirical representations of stratospheric species; on studying systematic varitions of measured constituents; and on using available analytical models to expand existing and future data sets and provide the rationale for future measurement sets. The approach will be to study and develop advanced concepts for long duration observation of stratospheric species; define key species in major chemical chains and use these results to study measurement requirements and to support the advanced concepts; develop and apply techniques needed to form a data base from all relevant sources and compare existing data from ground, aircraft, balloon, rocket, and satellite to transport and radiation to gain improved understanding of physical processes; and design remote sensing strategies.

W82-70369 **146-60-02**
Langley Research Center, Hampton, Va.
MISSION AND SAMPLING ANALYSES FOR ATMOSPHERIC SATELLITE EXPERIMENTS
Edwin F. Harrison 804-827-2977
(146-60-01; 147-40-01)

The objectives of this RTOP are to perform orbital analyses and sampling simulations to define mission concepts for advanced atmospheric research satellite experiments. These analyses will be performed in collaboration with scientific groups and instrument developers to define orbital parameters and sensor viewing characteristics that will meet the measurement requirements of the mission. Sampling analysis will be conducted for experiments being considered for the Upper Atmospheric Research Satellites (UARS). Time and space coverage data will be generated and analyzed by utilizing the Langley developed TRACK-2 orbital sampling computer program. Orbit inclination, altitude, launch time, and sensor scan angles will be optimized to meet mission objectives. These results will also be used in trade off studies to determine the best compromise of scan angles and sampling strategy to obtain commonality of conceptual instrument designs for various orbital geometries, solar variations, mission options, and sensor operation modes. The orbital sensor sampling results will be used in conjunction with atmospheric chemistry and dynamic models to quantify the overall science capability of the various experiments and mission concepts.

W82-70370 **146-60-03**
Langley Research Center, Hampton, Va.
ATMOSPHERIC LIDAR SYSTEM DEFINITION
Jack E. Harris 804-827-3951

The objective is to continue the atmospheric lidar multi-user instrument system definition activity with emphasis on experiment analysis using realistic lidar system parameters and atmospheric conditions. In addition an in-house study will be conducted with the objective of defining a limited capability shuttle lidar instrument with emphasis on tropospheric measurements.

W82-70371 **146-60-04**
Langley Research Center, Hampton, Va.
SCIENCE SUPPORT FOR THE ATMOSPHERIC TRACE MOLECULE SPECTROSCOPY (ATMOS) EXPERIMENT
J. M. Russell, III 804-827-2576

The objectives of this research are to: (1) analyze existing and future spectral data from balloon flights of the JPL High Speed Interferometer and use the results from this analysis to assist the ATMOS science team in the selection of optimum spectral regions for remote sensing of ATMOS assigned gases; (2) independently develop spectral simulation and gas concentration retrieval algorithms for verification of the analysis by JPL; (3) develop operational pressure and temperature retrieval algorithms for use by ATMOS; and (4) apply the detailed information derived from analysis of both balloon and satellite spectra to the design and development of data reduction software for gas specific satellite experiments, especially HALOE and ALS. The approach is to work with the JPL interferometer data, with atmospheric data, obtained from other sources, and with labortory data in order to obtain information about the state of the stratosphere from the interferometer data; to develop and refine software capabilities for analysis of high resolution atmospheric spectra (spectroscopic data base, spectral manipulation techniques, retrieval algorithms, and simulation techniques); and to compare analysis techniques and results with those derived by JPL. With these analyses and software capabilities it will be possible to make significant contributions to other major ongoing satellite experiments.

W82-70372 **146-90-01**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT SUPPORT FOR AERONAUTICS AND SPACE APPLICATIONS PROGRAMS
Byron E. Batthauer 216-433-6139

The objective of this research is to provide Lear Jet aircraft support for aeronautical research, remote sensing applications, and periodic flight checks for the Shuttle Orbiter Microwave Landing System. The approach is to assure an operationally ready flight facility by satisfying equipment, maintenance, and operations requirements over and above individual research program objectives. This approach includes provisions for maintaining aircrew proficiency, complying with required Airworthiness Directives and maintaining basic mechanical, electrical and avionics systems.

Upper Atmospheric Research

W82-70373 **147-10-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - FIELD MEASUREMENTS
R. D. Hudson 301-344-6358

This research will: (1) determine the specific local chemical and physical interactions in the atmosphere by a combination of theoretical studies and coordinated in situ measurement campaigns from balloon, rocket and aircraft platforms; (2) investigate the variations and perturbations of the chemical and physical state of the atmosphere, i.e., variations with altitude, solar conditions, season, latitude, and perturbations from volcanoes, tropical storms, industrial and agricultural activity; and (3) develop and calibrate selected instruments for local and remote investigations of the atmosphere. The approach is to develop a balloon borne LIDAR system, a Michelson interferometer spectrometer, sub-millimeter radiometers, and a photoionization mass spectrometer to measure the concentrations and diurnal variations of trace stratospheric species. Also, laboratory studies of the resonance fluorescence of stratospheric species will be performed by single and two photon excitation in support of the LIDAR experiments. Also, the approach is to measure ozone and the direct and diffuse components of the solar flux in the stratosphere and mesosphere, and to perform multi-instrument, coordinated measurements of minor species in the stratosphere and mesosphere. The results will provide improvement and validation of photochemical models, improvement of understanding of upper atmosphere dynamics and transport, and determination of in situ solar flux and the accuracy of radiative transfer calculations.

W82-70374 **147-10-02**
Jet Propulsion Laboratory, Pasadena, Calif.
STRATOSPHERIC RESEARCH, FIELD MEASUREMENTS PROGRAM
C. B. Farmer 213-354-2140

The primary objective of the Jet Propulsion Laboratory (JPL) Upper Atmospheric Measurements Program is to obtain reliable data on the concentrations and distributions of the minor and trace species in the Earth's upper atmosphere. These data are used in turn by modelers and dynamicists to assess and predict the effects of changes in the chemical contents of the stratosphere due to man's activities. The measurements are acquired using five different techniques: (1) infrared interferometry, (2) infrared heterodyne radiometry, (3) millimeter and submillimeter radiometry, (4) pressure modulated infrared radiometry, and (5) laser absorption spectroscopy. The instruments used for the first three techniques have all been developed at JPL, and the fourth utilizes instruments on loan from Oxford University. The instrument for laser absorption spectroscopy is currently being developed by JPL. The first four techniques involve remote sensing, while the fifth measures absorption between a balloon gondola and a lowered reflector. In addition to the instrumentation, a multi-sensor gondola has been developed by JPL which is capable of supporting all four of the remote sensing instrument on a single joint flight. Longer term goals of the program include continued multi-sensor balloon measurements as needed and certain measurements (e.g., ClO) with individual sensors. When appropriate, these measurements will be coordinated with related measurements by other groups. Development of instruments to measure additional species (e.g., submillimeter radiometry for emission measurements of OH, HCl, atomic O, HOCl and other species; improved laser radiometry for HO2 and other species) is also included in the program. In addition to providing instruments for balloon and aircraft measurements these developments will be valuable for future instruments to perform global monitoring from the space shuttle and free flier satellites.

W82-70375 **147-10-03**
Ames Research Center, Moffett Field, Calif.
ATMOSPHERIC PROCESSES, EXPERIMENTS AND SYSTEMS
W. A. Page 415-965-5404
(146-10-04; 146-20-10)

The research objectives are to perform studies of stratospheric transport, and tropospheric stratospheric exchange processes, and to obtain benchmark data on important stratospheric species. Observational data from balloon, aircraft, and satellite instrumentation are utilized. Measurements are made of the meteorological field parameters, winds, temperature, pressure, and atmospheric tracer species such as CFMS, N2O, water vapor, O3, CO, and aerosols. Coordinated simultaneous measurement sets are emphasized. The current interest is stratosphere water vapor transport and water vapor budget. The approach is to form experiment working groups composed of experiment principal investigators and additional experts in atmospheric processes. Workshops are held, appropriate experiments are designed to study important processes, some instrumentation is developed as appropriate, cooperative experiments are conducted, and the results are subsequently analyzed, and published. Typical experiment platforms are NASA's U-2, ER-2, and CV990 aircraft.

W82-70376 **147-20-01**
Jet Propulsion Laboratory, Pasadena, Calif.
CHEMICAL KINETICS
William B. DeMore 213-354-2436

A program of laboratory studies will be conducted in the areas of chemical kinetics of the upper atmosphere, photochemistry of the upper atmosphere, and data survey and evaluation. The program will be designed to provide data needs and guidance for both chemical models and field measurements. Primary emphasis will be on the acquisition of kinetic data including reaction rate constants, temperature dependences, and product formation. Photochemical quantum yields, absorption cross sections, and product distributions will be measured. A broad base of data knowledge in all the foregoing areas will be maintained through literature surveys and through contact with other groups active in these areas.

W82-70377 **147-20-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - LABORATORY MEASUREMENTS
R. D. Hudson 301-344-6358

The goal of this research will be to measure chemical kinetic rate coefficients of importance to the stratosphere and mesosphere. The laboratory effort in chemical kinetics uses existing equipment of unique capability for the purpose of measuring absolute rate constants of reactions of importance in current models of the stratosphere. Rate constants are measured as a function of temperature and pressure and under conditions in which the number of atoms is much less than the number of molecules. This research will contribute to the knowledge of chemical reaction rates at temperatures and pressures appropriate to the upper atmospere.

W82-70378 **147-20-03**
Ames Research Center, Moffett Field, Calif.
QUANTITATIVE INFRARED SPECTROSCOPY OF MINOR CONSTITUENTS OF THE EARTH'S STRATOSPHERE
Charles Chackerian, Jr. 415-965-6300

Remote detection and measurement of stratospheric species via spectroscopic techniques is being routinely employed to develop a better understanding of this portion of the atmosphere and man's effect upon it. Proper interpretation of these measurements relies strongly on having the correct laboratory data. The objective of this work is to obtain laboratory measurements of basic molecular parameters, such as rotational line intensities and half-widths, absorption band intensities, vibrational and rotational constants, vibration-rotation interaction constants, line position measurements including pressure induced shift, and Franck-Condon factors. The determination of these parameters, and their dependence on pressure and temperature, will be obtained by using long path gas cells, cooled and heated cells, and high resolution interferometers and spectrometers.

W82-70379 **147-20-03**
Jet Propulsion Laboratory, Pasadena, Calif.
CALIBRATION SPECTRA
W. Huntress 213-354-2140
(147-10-02)

A program of laboratory studies related to stratospheric research will be conducted in infrared laboratory spectroscopy, laser laboratory spectroscopy, and millimeter and submillimeter laboratory spectroscopy. The program involves the acquisition and analysis of molecular spectral parameters which are required for the interpretation of data from stratospheric measurement. The laboratory spectral measurements will be conducted specifically in support of the JPL infrared interferometer, infrared laser, and millimeter radiometer instruments. Each instrument has its own requirements relative to spectral region of operation, spectral resolution, and molecules for which it is best suited. The laboratory measurements are therefore divided into three categories. In each category, emphasis is placed on accuracy of line frequency, line width, and line strength measurements, in order to take full advantage of spectroscopic techniques for quantitative atmospheric species measurements. A large portion of the spectral data will also be of value to other groups who use spectroscopic instruments for atmospheric measurements.

W82-70380 **147-20-03**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION INFRARED MEASUREMENTS OF ATMOSPHERIC TRACE GASES
R. S. Rogowski 804-827-2818
(176-10-32; 506-18-23)

High resolution infrared spectra will be measured for atmospheric trace gases to obtain spectral parameters required for interpretation of data from remote sensing instruments. Diode lasers which are narrow band and tunable will be used as sources so that complex molecules can be studied at high resolution with minimum distortion of line shapes. Line positions, strengths, and broadening coefficients will be measured and absorption lines will be identified by the quantum level involved in the transition. Transient and unstable gases can be generated in a flow/reactor system that has been successfully operated for high resolution infrared studies of ClO. This facility can be used to produce other gases of importance to stratospheric chemistry by simply changing the reactant species. The systems will be used to synthesize other gases and is currently being applied to the production of HO2 species concentrations in the absorption cell and are monitored by UV absorption measurements which can be made simultaneously with the IR observations. The facility will be used to measure positions and intensities of HO2 radical and H2O2.

W82-70381 **147-30-01**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERIC RESEARCH - THEORETICAL STUDIES
R. S. Stolarski 301-344-5485

The objectives of this RTOP are to: (1) provide the framework for developing and understanding an organized solid body of knowledge of the physics, chemistry, and dynamics of the Earth's upper atmosphere; (2) analyze data from upper atmospheric flight programs; and (3) predict and assess the effects of natural and man related perturbations on the atmosphere. The approach will be to: (1) continue to develop and utilize a hierarchy of models of upper atmospheric photochemistry, radiation, and dynamics ranging from simplified one dimensional models to a global general circulation model with chemistry and (2) utilize NIMBUS 4, NIMBUS 7, SMM, and other data to elucidate the controlling mechanisms for atmospheric composition and variations. Improved photochemical models, improved understanding of the coupling between chemistry and transport, and improved understanding of the dynamics of the ozone layer are expected results of this RTOP.

W82-70382 **147-30-01**
Langley Research Center, Hampton, Va.
STRATOSPHERIC THEORETICAL STUDIES AND SCIENCE DEFINITION ACTIVITIES
R. H. Tolson 804-827-2530

The objective of this RTOP is to conduct theoretical studies of stratospheric phenomena in conjunction with the analysis of stratospheric data and computational chemistry studies of reactive stratospheric molecules. Using comtemporary satellite data, theoretical studies will be performed in the general area of photochemistry, trace constitutent budgets, and the three dimensional distribution of minor constitutents. Balloon measurements of NO and NO2 will be inverted, interpreted for diurnal variations, and compared to time dependent model calculations. These results will be related to LHS experiment definition studies. Computational chemistry studies will focus on determining the ground state structure, excited states, and heat of formation of highly reactive species.

W82-70383 **147-30-01**
Jet Propulsion Laboratory, Pasadena, Calif.
PHOTOCHEMICAL MODELING FOR FIELD MEASUREMENTS
Wesley T. Huntress, Jr. 213-354-2140

This work will be performed via a Research and Development

contract to Professor Y.L. Yung, California Institute of Technology (Caltech Contract 064207). He will use the one dimensional diurnal photochemical model to investigate the distribution of minor species in the stratosphere and mesosphere in support of the JPL joint balloon experiments and the laboratory kinetics program. An understanding of the partitioning between the ClOx family, ClO, HCl, HOCl, and ClNO2; and the NOx family NO, NO2, HNO3 and HO2NO2, and measurement strategy will be one of the primary objectives.

W82-70384 **147-30-02**
Ames Research Center, Moffett Field, Calif.
STRATOSPHERIC RESEARCH
E. F. Danielsen 415-965-5527
(147-20-03; 146-10-04)

The objectives of this research are to increase our understanding of the dynamics, thermodynaics, and composition of the Earth's stratosphere and mesosphere, with emphasis on atmospheric transport and its effects on the distributions of energy, momentum, and trace constitutents, such as water vapor, ozone, etc. The research includes development of numerical, predictive, and diagnostic models in three dimensions. The predictive spectral model being developed at Ames, is sufficiently general to permit analysis of the effects on the stratosphere of waves generated in the troposphere by baroclinic instability or surface topography. A much simpler model of the middle atmosphere developed at the University of Washington emphasizes low wave number interactions in the stratosphere and mesosphere. The diagnostic models being developed at San Jose State and Ames will be applied both to actual atmospheric observations and to predictions made by the NOAA-GFDL general circulation model. From both data sets, vertical as well as horizontal velocities will be derived and analyzed statistically for transport parameterizations in two dimensional models. Complementary to these large scale studies, radiosonde and U-2 measurements from experiments conducted in the tropics are being analyzed for mesoscale transports and trospheric-stratospheric exchange in the tropics. Ab initio computations of molecular processes important to stratospheric photochemistry are also being carried out.

Space Processing

W82-70385 **179-13-72**
Lyndon B. Johnson Space Center, Houston, Tex.
BIOPROCESSING STUDIES
Dennis R. Morrison 713-483-5281
(179-13-62)

The objective of this RTOP is to provide general biological expertise (cell handling, cell culture, cell separation, bioassays) for the support of the biological projects of the materials processing in space program. The JSC Bioprocessing Laboratory will coordinate the tissue culture, bioassays, and cell characterization phases of projects with MSFC, university based investigators, and NASA Hqs. A major portion of the program is currently devoted to in house laboratory evaluation of ground based cell separation and cell culture techniques. Emphasis is placed on developing practical techniques required to achieve maximum cell viability and growth before and after electrophoretic separations and on cell product assays. Limitations of ground based cell culture are also being evaluated, and technical problems and/or advantages of culturing mammalian cells under weightless conditions are being identified.

W82-70386 **179-15-20**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTIMODE ACOUSTIC RESEARCH
Martin Barmatz 213-354-3088
(179-13-20; 179-50-20)

This RTOP will provide fundamental research support for the advanced containerless processing technology program. Recently, new classes of acoustic levitation have been discovered at JPL in rectangular, cylindrical and spherical geometries that may be attained by the excitation of multidimensional acoustic modes (multimodes). These new levitation principles provide us with advanced alternative methods for positioning and manipulating molten materials, which may lead to rapid cooling, selection of arbitrary axes of rotation, and separation of levitation and rotation capabilities. The long term objectives of this RTOP are: (1) to develop theoretical acoustic models of these new multimode levitation classes; and (2) to provide experimental validation of these models using research levitation devices. The FY 82 activities will provide a more fundamental understanding of these acoustic multimode levitation properties. Since this will be the first year of the RTOP, the emphasis will be primarily theoretical, while a new research laboratory is established. The objectives for FY 82 are to: (1) determine stable acoustic levitation positions of these multimodes; (2) establish the acoustic force expressions associated with these levitation positions; and (3) investigate the dependence of the multimode levitation and manipulation capabilities on chamber dimension ratios.

W82-70387 **179-20-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CONTAINERLESS PROCESSING TECHNOLOGY
T. G. Wang 213-354-6331
(179-10-20; 179-50-20)

The long-range objectives of this task are to: (1) study and advance the science of contactless positioning and manipulation in a high temperature acoustic containerless processing chamber, (ii) provide potential Material Processing in Space investigators with a set of ground-based facilities with which to perform precursor experiments. Under this RTOP, breadboards for high temperature containerless processing systems will be developed, the principles of operation will be studied, the performance will be characterized, the limitations identified, and the influence of the acoustic field on the samples established. The subjects to be addressed in FY-82 are experimental and theoretical studies of: (1) acoustic positioning and manipulation capabilities in a high temperature environment (> 600 C); (2) acoustic field, sound attenuation, phase shift, and sample stability associated with high temperature gradient environment; (3) high temperature ground based levitation systems which will alow us to melt, process, and solidify samples without crucibles in the laboratory; and (4) KC-135 and laboratory tests of various acoustic geometries which may have special applications in Material Processing in Space Program.

W82-70388 **179-20-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CONTAINERLESS PROCESSING TECHNOLOGY
T. G. Wang 213-354-6331
(179-10-20; 179-50-20)

The long-range objectives of this task are to: (1) study and advance the science of contactless positioning and manipulation in a high temperature acoustic containerless processing chamber and (2) provide potential Material Processing in Space investigators with a set of ground-based facilities with which to perform precursor experiments. Under this RTOP, breadboards for high temperature containerless processing systems will be developed, the principles of operation will be studied, the performance will be characterized, the limitations identified, and the influence of the acoustic field on the samples established. The subjects to be addressed in FY-82 are experimental and theoretical studies of: (1) acoustic positioning and manipulation capabilities in a high temperature environment (ch110]600 C); (2) acoustic field, sound attenuation, phase shift, and sample stability associated with high temperature gradient environment; (3) high temperature ground ased levitation systems which will allow us to melt, process, and solidify samples without crucibles in the laboratory; and (4) KC-135 and laboratory tests of various acoustic geometries which may have special applications in Material Processing in Space Program. In addition, this RTOP will continue to provide design information to Acoustic Containerless Experiment System (ACES) and establish the operating conditions for ACES, and support activities to further define and help establish the rationale of new experimental areas which may benefit from acoustic containerless processing.

W82-70389 **179-20-56**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTROSTATIC CONTROL AND MANIPULATION OF MATERIAL FOR CONTAINER PROCESSING
D. D. Elleman 213-354-5182
(179-13-20)

The primary long-range objective of this task is as follows: The development of the science and technology base that is required for contactless positioning and manipulation of high temperature materials using electrostatic fields. An electric field containerless processing module (EFCPM) operating at room temperature satisfying requirements of selected potential investigators will be demonstrated no later than FY-83. This will lead to the design and development of a high temperature facility and flight models of the EFCPM. The effort will include laboratory and theoretical investigations; in addition, low gravity test of breadboard development models will be tested on the KC135 aircraft. The second major objective is the development of requirements of potential investigators. An Electric Field Positioning Science Working Group, has been formed so as to guide technology by imposing well defined, specific requirements. This group will play the major role in defining facility requirements. An individual investigator would be funded through response to NASA AN's, and the funding administered under this RTOP. The near term objectives to be addressed in FY-82 include the low gravity test of the room temperature bulk electrostatic positioning module. Also, laboratory work will be initiated to study the electric charge loss at elevated temperatures. A room temperature liquid deployment and electric charging system will be developed and tested on the low gravity test module. A laboratory electrostatic positioning test module that will operate in a vacuum will be developed. The Science Working Group will supply inputs for the development of the EFCPM; in addition, pertinent development tests and experiments solicited from the working group will be conducted on the low gravity test facility.

W82-70390 **179-20-57**
Jet Propulsion Laboratory, Pasadena, Calif.
FUSION TARGET TECHNOLOGY STUDY
T. G. Wang 213-354-6331
(179-13-20)

The objectives of this RTOP are to: (1) provide improved understanding of the physical processes relevant to the production of spherical shells for inertial confinement fusion targets, both in the laboratory, and in a weightless environment, (2) provide technical information to DOE centers that is pertinent to their shell fabrication research, (3) develop technology applicable to the production of a novel high strength, low weight, structural material using metallic or amorphous spherical shells. In order to produce the high quality spherical shells that are required, three parameters must be controlled accurately: the shell dimensions; shell sphericity and concentricity; and the surface topology of the shell. The present shell fabrication techniques are not set up to study the fundamental physical processes associated in controlling those parameters separately. Attempts to conduct experiments on the dynamics of liquid bubbles (molten shells) in laboratories are limited by a strong coupling among the three parameters, time, gravity, and temperature. The work described here will circumvent these limitations and enable detailed study of each of the important processes through use of low gravity environments collectively available in drop towers, in a neutrally buoyant immiscible system, and in a acoustic levitation system.

W82-70391 **179-31-99**
Marshall Space Flight Center, Huntsville, Ala.
EXPERIMENT OPERATIONS
R. P. Chassay 205-453-1663

The objectives of this RTOP are to provide, maintain, and operationally support the test capabilities for precursory reduced gravity experimentation through a spectrum of facilities and test beds, and to provide the experimental support equipment necessary and incidental to the precursory testing. As an integral part of the materials processing in space ground-based research and flight experiment development activities, reduced gravity test data are required to establish experiment parameters, to establish proof-of-concept, and to provide specimens for laboratory tests. Many of these requirements can be satisfied with small amounts of low-g experiment time. Thus, ground-based facilities such as drop tubes and a drop tower which provides 2 to 4 seconds, aircraft which provide 10 to 50 seconds, and sounding rockets which provide 240 to 360 seconds of microgravity are valuable methods for experiment accommodation. Additionally, experiment apparatus will be converted from sounding rocket configuration to that necessary for usage in the Materials Experiment Assembly. The present plan is to operate existing facilities/capabilities, including two drop tubes a drop tower, and parabola aircraft.

W82-70392 **179-40-62**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED RESEARCH AND DEVELOPMENT ACTIVITY (AR&DA) SUPPORT
J. C. Hughes 205-453-4956

The objectives of this RTOP are: (1) to provide the necessary management and support manpower to implement the material processing in space (MPS) research and technology development effect and (2) to provide the MPS program with an effective means of interacting with the various scientific communities. The stated objectives will be met by actively involving the various research communities in the MPS program through working groups, seminars and workshops, science reviews, and a visiting scientist program. In addition, scientific goals and accomplishments of the program will be documented and disseminated to the science communities in the form of a published bibliography and catalog of tasks.

W82-70393 **179-45-00**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANNING FOR SPACE MATERIALS SYSTEM (SMS) PROGRAM
H. K. Frewing 213-577-9309
(179-46-20)

The objective of this RTOP is to plan for activities which will lead to cost effective use of space materials in space. In this RTOP, SMS refers to the acquisition and use of space materials in space; not to the use of space materials on Earth, the use of terrestrial materials in space, or the processing of terrestrial materials in space for return to Earth. Achieving this ultimate goal will be a very long term process, so the immediate objective in FY82 is to modify and update the SMS plan that is scheduled to be produced in October 1981. This updating will be done in conjunction with the companion SMS Study RTOP, which will investigate specific technologies required for exploitation of space materials, and interacting with other NASA offices and centers and with private industry and academia.

W82-70394 **179-46-00**
Jet Propulsion Laboratory, Pasadena, Calif.
RESEARCH IN THE USE OF SPACE RESOURCES
H. K. Frewing 213-577-9309
(179-45-20)

The basic space materials systems program plan specifies the objectives and goals for future missions. In order to implement this plan initial details are required to define the basic requirements of a system including: (1) resource exploration and identification; (2) extraction and beneficiation; (3) bulk materials processing; (4) engineering materials processing; and (5) fabrication and assembly of components; structures, etc. The objective of this RTOP is to study several of these areas to determine and analyze the significant factors applicable to the overall mission. The following tasks are to be performed during FY 1982: (1) description of lunar and asteroid resources as presently known with recommendations for future exploration requirements; (2) studies of methods for extraction and processing of extraterrestrial resources and basic bench type experiments if applicable; (3) advanced artificial intelligence studies for automation; (4) studies of basic energy and transportation problems for utilization of space materials in space; and (5) studies of utilization missions with cost benefits analysis. Effort will include options in staging missions.

W82-70395 **179-47-00**
Jet Propulsion Laboratory, Pasadena, Calif.
EXTRATERRESTRIAL MATERIALS PROCESSING
P. G. Gordon 213-354-8610
(179-45-20; 179-46-20)

The objective of this RTOP is to develop a program plan for the utilization of space resources. This plan, titled 'Space Materials Systems' was requested by the NASA Administrator to be submitted by August 1, 1981 for approval. A copy of the directive dated Nov. 4, 1980 is attached to this RTOP. The development of this plan will be a joint effort of the NASA Centers, Headquarters, and JPL. Coordination will be provided by P.G. Gordon who will be assigned to NASA Headquarters as a detailee. Following the approval of the overall plan, first phase detailed planning will start, utilizing an approach similar to the original development of the plan.

W82-70396 **179-60-62**
Marshall Space Flight Center, Huntsville, Ala.
COMMERCIAL MATERIALS PROCESSING IN SPACE
R. L. Brown 205-453-4880

The overall objective of this RTOP is to foster commercial uses of Materials Processing in Space (MPS) technology in ways which will lead to new or improved processes/products on Earth and in space, and thus to benefits for the general public. The overall approach involves working directly with private and select federal organizations to simulate interest in materials processing in space (MPS) and lay groundwork for use of MPS in ways which will benefit the public. Due to the embryonic nature of MPS technology at this time, an indepth working relationship must be established with interested organizations wherein they can develop an understanding of how MPS technology can meet their specific needs. Also, the factors which influence the adoption and diffusion of the technology must be understood. This RTOP provides for developing three progressive levels of working relationships on a case by case basis, as well as for developing an understanding of the technical and institutional issues which influences technological innovation based on MPS technology.

W82-70397 **179-70-10**
Jet Propulsion Laboratory, Pasadena, Calif.
ACOUSTIC CONTAINERLESS EXPERIMENTS SYSTEM (ACES)
D. J. Kerrisk 213-354-2566
(179-13-20; 179-15-20)

The objectives of this RTOP are to: (1) establish the technology base, in terms of high temperature furnace design, acoustic power transfer, optical and LR imaging capability and ultrasonic sample detection, for high temperature processing of materials in space using acoustic containment; (2) perform a preliminary design of a first Acoustic Containerless Experiment System (ACES), and identify the major system technology uncertainties that need to be addressed in a hardware sense prior to commitment to flight system development; (3) perform the preliminary design of a brassboard ACES to address those technology uncertainties amenable to ground resolution; (4) perform a preliminary design of a mid-flight deck experiment to address those technology uncertainties that can only be resolved in a micro-gee environment, and (5) design the modifications needed to the existing SPAR 77-18 instrument to upgrade its science capability and interface it with the Materials Experiment Assembly (MEA).

W82-70398 **179-70-62**
Marshall Space Flight Center, Huntsville, Ala.
MPS SYSTEMS DEFINITION
I. C. Yates 205-453-5961

The primary emphasis of this RTOP is to reduce the technical and programmatic risk of new hardware systems through resolution of technology and design problems before initiation of the hardware new starts. The implementation is through the development and testing of breadboards of sufficient fidelity that the Phase B effort is a matter of packaging the systems for flight and developing the attendant programmatic data. The key technology issues listed below will be addressed in the breadboards. Fortunately, many of the apparatus design solutions will have multiple applications and will crosscut several areas of technology, so there is an efficiency to be gained by doing several of these equipment developments together. Following is a list of breadboards for development of process technology and feasibility studies for analysis of capabilities for fulfilling MPS payload requirements.

W82-70399 **179-80-10**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED DETECTOR MATERIALS PREPARATION
John A. Zoutendyk 213-577-9202
(179-02-62; 179-03-62)

The research program is aimed at the exploitation of the low gravity space environment for the growth of single crystal materials for infrared (IR) detectors, having characteristics unattainable in an Earth gravity growth configuration. The long term objective is to determine the effect(s) of gravity driven convection in physical vapor transport crystal growth of PbSnTe. The objective for FY-82 is to complete crystal growth and characterization studies of this compound semiconductor material. Our crystal growth is done by closed tube sublimation in transparent furnaces. This enables the direct observation of the growth interface during actual vapor transport. Crystals are grown under various conditions of temperature, orientation with respect to gravity, etc.

W82-70400 **179-80-30**
Marshall Space Flight Center, Huntsville, Ala.
CONTAINERLESS PROCESSING
J. R. Williams 205-453-5961

The objectives of this activity are to: (1) explore novel techniques and applications for containerless processing of glasses and refractory materials; (2) understand the limitations imposed by the gravitational field; and (3) evolve meaningful flight experiments which extend processes beyond gravity limitations. Containerless processing in space requires low level levitation forces to compensate for mirogravity acceleration and maintain position of the sample. The central reason is the elimination of extraneous effects from contact with solid containment walls. The implementation of appropriate experiments will involve the following: (1) a 31-meter drop tube at MSFC provides 2.6 seconds of free fall for solidifying molten droplets up to several mm diameter; (2) a single axis acoustic levitator has been developed which uses a high-Q driver with a single resonant frequency; (3) a three-axis acoustic levitator has also been under development involving three mutually orthogonal drivers which produce a three dimensional sound field (spherical energy well) in a tuned cavity; (4) a 10 kW electromagnetic levitator facility, which by careful coil design maximizes Grad B/B, is in use to levitate samples with a minimum of heating; and (5) aerodynamic levitation using a jet of air from a carefully designed nozzle has been used to suspend highly reactive samples.

W82-70401 **179-80-30**
Jet Propulsion Laboratory, Pasadena, Calif.
CONTAINERLESS PROCESSING
George F. Neilson 213-354-6365
(179-65-10; 179-13-20)

The overall objective of this RTOP is to obtain both fundamental and practical information pertaining to the preparation and processing of glasses in a space environment. The present studies will continue efforts that are being conducted currently under the two RTOPs, glass research and nucleation and crystallization of glasses. These efforts will establish a quantitative scientific basis for containerless experiments with glass forming materials. The objectives for FY-82 are to: (1) determine the variation in behavior and microstructural properties of gel derived glasses as functions of the gel and glass preparation procedures; and (2) study the nucleation and crystallization behavior of simple oxide glasses.

W82-70402 **179-80-51**
Lewis Research Center, Cleveland, Ohio.
REDUCED GRAVITY COMBUSTION SCIENCE
Thomas H. Cochran 216-433-4000
(506-56-22)

The objective of this effort is to conduct research in space

on fundamental combustion phenomena to define governing mechanisims, validate theoretical models, and obtain unique data unavailable to date because of the limiting and masking effects of gravity. The program will consist of four specific efforts; namely: (1) a baseline research activity directed at continuing the ongoing activity of concept definition and justification of potential combustion experiments; (2) the formation of a science working group which will not only provide advise on the overall scientific content of the program and define the scientific requirements for flight experiments and suppoting facilities, but will also participate in an advisory capacity in the development of the experimental hardware; (3) an experiment apparatus analysis, development, and testing activity which will be devoted to developing the required experiments and instrumentation concepts; and (4) the development of a spacelab combustion facility as well as experimental hardware for use in the orbiter middeck, both of which will be used to conduct combustion science experiments in space. The LeRC will provide the technical and management suppot to direct all contract activities and to provide coordination between government groups, contractors, and the scientific community associated with his effort.

W82-70403 **179-80-60**
Marshall Space Flight Center, Huntsville, Ala.
SOLIDIFICATION PROCESSES
J. R. Williams 205-453-5961

Control of the solidification of metals and alloys is keyed to gravitational effects such as buoyancy driven convection. Thus, the objectives of the study are to: (1) identify various aspects of solidification phenomena that may be affected by gravity driven flows; (2) devise and conduct critical experiments in both increased gravity as well as in space; and (3) impact the field of metallurgy by fundamental knowledge through devising better control strategies. Multicomponent metallic systems involve a first-to-freeze component which nucleates and begins to grow, causing the composition ahead of the solidification front to change dramatically. Where it is infeasible or undesirable to provide controlled gradients for a planar solidification front, dendritic growth results. Thus, concentration is one of the more fundamental problems involved in the formation of dendrites. Directional solidification affords a degree of control because unidirectional thermal gradient can be imposed and growth rate regulated. Another important class is the monotectic alloys which have a region of immiscibility. Finally, nucleation and rapid solidification of deeply undercooled melts will be pursued by containerless melting and solidification.

W82-70404 **179-80-70**
Marshall Space Flight Center, Huntsville, Ala.
CRYSTAL GROWTH PROCESSES
J. R. Williams 205-453-5961

In any crystal growth system, an important problem is that the compositional and/or thermal fluctuations in the fluid phases cause compositional inhomogeneities and defects in the growing crystal. Where these fluctuations are caused by convection and sedimentation, they can be reduced in low gravity. Therefore, the major objectives of this crystal growth program are to: (1) understand the role of gravity and determine limitations in Earth's gravity; (2) determine and demonstrate advantages to be obtained by growing crystals in space; and (3) apply the findings to help solve problems in the growth of electronic and detector crystalline materials. The types of growth that will be explored in this program include melt, solution, vapor, and float zone growths. Crystal growth by solidification from the melt is the most widely used technique for high technology single crystalline materials. The success of the technique depends on the control of the composition, temperature, and morphology of the solidification interface. Advantages of this technique include the control it provides over the temperature of growth and viscosity. In the vapor approach, there are two distinct mechanisms for growing a crystal: (1) the physical vapor deposition and (2) chemical vapor deposition. Finally, floating zone crystal growth is accomplished by supporting a polycrystalline rod at both ends; melting a portion of it with a moving heater, and growing a crystal behind this zone.

W82-70405 **179-80-80**
Marshall Space Flight Center, Huntsville, Ala.
BIOSEPARATION PROCESSES
J. R. Williams 205-453-5961

The long range objective is to utilize the environment of space to separate and purify biological products. The intermediate objectives are to develop the required technology and to expand the base of knowledge involved with processing biologicals in space; to identify, evaluate and select the most promising processes; and to explore new areas of separation technology. Separation and purification procedures which have been found to produce inadequate results on the ground because of gravity dependent problems will be evaluated and investigated. More specifically, this program will: (1) determine possible advantages of the low gravity environment for separation and characterization of biomedical materials; (2) design and conduct experiments in space; (3) apply ground/flight knowledge to the improvement of bioprocessing procedures on Earth; (4) develop broad and strong collaborative interactions with reseachers; and (5) identify and explore new techniques of separation or bioprocessing that might be enhanced by low gravity. The research is directed toward answering these fundamental questions.

Technical Consultation and Support Studies

W82-70406 **643-10-01**
Lewis Research Center, Cleveland, Ohio.
TECHNICAL CONSULTATION SERVICES
E. F. Miller 216-433-4000

The object of this research is to: provide technical consultation services support in the area of space services with particular emphasis on preparing for international meetings relating to the fixed-satellite servive (FSS), the broadcast-satellite service (BSS), and the mobile-satellite service (MSS); provide the technical basis and regulatory support needed to obtain sufficient orbit/spectrum to meet current and projected requirements of NASA and the United States; and perform studies, develop analytical methods for planning, conduct evaluations, identify technology status and needs, perform critical technology developments, perform measurements (where necessary) to determine sharing criteria, and evaluate alternatives that result in efficient and cost-effective use of the geostationary orbit/spectrum resource. Specifically, these activities will: (1) support domestic and international preparations for the 1983 RARC (Regional Administrative Radio Conference) on broadcasting satellites at 12 GHz; (2) support domestic and international preparations for the 1984/1986 Space Services Warc with emphasis on the FSS and the BSS; and (3) support domestic and international MSS planning in the 806 to 890 MHz band. The described activities will be conducted within the framework and schedules of the applicable CCIR Study Groups, the special preparatory committees established in the U.S., and the national and international meetings called to support preparations for the conferences. Efforts planned are a combination of in-house and contract activities.

W82-70407 **643-10-01**
Jet Propulsion Laboratory, Pasadena, Calif.
TECHNICAL CONSULTATION SERVICES
T. A. Komarek 213-354-3753
(643-10-02; 643-10-03; 643-10-04)

The objective of this RTOP is to ensure the growth of space applications by providing the technical basis and regulatory framework needed to obtain sufficient spectrum/orbit to meet current and projected requirements. The results of this work will be used by NASA to help determine its frequency and orbit requirements and to ensure compatibility between NASA flight programs and other space and terrestrial services. The results will also be used by NASA and other government agencies for the purpose of supporting CCIR and world and regional administrative radio conferences; in making decisions on frequency/orbit utilization and assignments, ground station and satellite approvals; and in providing for the growth of existing

and new satellite services. Particular attention will be given to: frequency/orbit use justifications; sharing criteia and implications; technical system standards; digital system modeling; frequency reuse characteristics of multiple beam antennas; spectrum conservation and error rate aspects of various modulation and coding techniques; multiple access and onboard signal processing and switching for more efficient satellite utilization; and intersatellite links. The current year activities will be directed primarily at the following areas: land mobile satellite (LMS) service, broadcast satellite service, and general orbit/spectrum utilization tradeoffs. specific tasks include: identification of LMS technical and operational characteristics, development of LMS channel simulator, analysis of multibeam antenna concepts and performance, analysis of satellite transponder linearity/modulation tradeoffs, parametric design study for a sound broadcasting satellite, and regulatory support for broadcasting satellite systems issues.

W82-70408 **643-10-02**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS SATELLITE NEW APPLICATION STUDIES
J. R. Ramler 216-433-4000
(643-10-01; 643-10-03; 541-02-15; 506-62-04)

The objectives of this RTOP are to: (1) conduct and complete concept feasibility studies for operational mobile satellite (MSAT) systems and initiate studies to define experimental MSAT requirements; (2) conduct appropriate pre-project management functions required for planning and establishing a mobile satellite program/project; and (3) define the technologies required to enable the implementation of operational MSAT systems in the mid 1990's and initiate supporting research and technology developments. The approach is to formulate and carry out a coordinated program of in-house and contracted studies leading to the development of all necessary system definitions, costs, schedules, justifications, endorsements, etc., to enable an FY-84 submission for a new project start for MSAT in FY-86. Cognizance of related studies and technology development activities at LeRC, JPL, LaRC, MSFC, and NASA HQ, as well as in other countries, will be maintained. Activities will be coordinated as required.

W82-70409 **643-10-02**
Jet Propulsion Laboratory, Pasadena, Calif.
COMMUNICATIONS SATELLITE NEW APPLICATION STUDIES
F. Nadert 213-354-6288
(643-10-01; 643-10-03; 641-02-15)

The objectives of this RTOP include aid in providing for the growth of existing satellite services and new communications satellite applications, and ensuring compatibility of NASA's communications flight programs with other space and terrestrial services. This aid is particularly related to NTIA's charter to facilitate the transfer of space technology for public service applications. Government procedures require all agencies to submit proposed new space systems concepts to Interdepartmental Radio Advisory Committee (RAC) and Office of Management and Budget (OMB) for review four to six years prior to their planned data of initial operation. This is to ensure spectrum availability for telecommunications systems prior to commitment of public funds. In order to fulfill this requirement, this RTOP will include studies of systems concepts with potential applications within the NASA communications program. These studies will include conceptual designs, user functional requirements, technical requirements, system descriptions, frequency and bandwidth requirements, cost effectiveness, system tradeoffs, and sharing studies required to demonstrate compatibility with existing or planned services. In FY-82 emphasis will be placed on conceptual system design and analysis for the land mobile satellite service. The studies will be consistent with an integrated narrowband program plan within the NASA communications program.

W82-70410 **643-10-03**
Jet Propulsion Laboratory, Pasadena, Calif.
PROPAGATION STUDIES AND MEASUREMENTS
E. K. Smith 213-354-6169
(643-10-01; 643-10-02; 643-10-04)

Radiowave propagation constraints in the Earth-space environment must be understood and accounted for in the design and specification of space communications systems. Propagation effects are becoming more significant as present technology moves to higher frequency bands (12/14 GHz, 20/30 GHz) to overcome spectrum and orbit congestion and to provide for new applications in space. The Propagation Studies and Measurements Program provides the focal point for national activities which support NASA's application programs, other government agencies, and the private sector in the development of prediction models, frequency allocation recommendations, orbit and spectrum use decisions, system specifications, and performance criteria related to space communications. Specifically, the objectives of this program are: (1) to provide an understanding and analysis of the basic propagation mechanisms which hinder reliable Earth-space communications; (2) to develop predictive models for the quantitative evaluation of these effects; (3) to provide the data base, from ground based satellite experiments, for the validation of predictive models and system performance; and (4) to support the orderly progress and insure effective utilzation of the frequency spectrum. Improvement in the estimation of link performance will be the guiding concern in this work. This program will be carried out in close association with systems planning of flight projects, thus insuring the relevance of the propagation studies. The products include: (1) CCIR contributions to Study Group 5 (and possibly 2 and 6) in Earth-space propagation and noise; (2) preparation of and contributions to NASA propagation handbooks; (3) presentations at meetings of URSI and IEEE; (4) journal articles; and (5) computer programs.

Advanced Communications Research

W82-70411 **650-20-16**
Lewis Research Center, Cleveland, Ohio.
ADVANCED SYSTEM STUDIES
J. R. Ramler 216-433-4000
(650-60-18; 643-10-02)

Advanced system studies are required to provide a continuing focus for NASA technology development and to help insure the relevancy of potential experimental satellite systems. The objectives of the studies are: (1) to assess and characterize the technical and economic requirements of potential operational satellite communications systems; (2) to identify and define potentially viable concepts and their technology requirements; and (3) to define appropriate experimental system requirements. A coordinated program of in-house and contracted studies will be formulated to assess the markets for satellite supplied communications services, define advanced satellite systems to meet the predicted market demands, and conduct network design/cost modeling and economic analyses to determine optimum approaches to implementing these advanced systems into existing communications networks. In some cases, these efforts will update, refine and extend previous market and advanced systems studies. In defining viable operational system concepts, technology developments required to enable implementation of the operational systems by the private sector will be identified and technology development plans will be defined. The need for experimental flight verification of the required technology and/or the service quality and reliability will be determined. Experimental flight system concepts will be defined where appropriate.

W82-70412 **650-60-20**
Lewis Research Center, Cleveland, Ohio.
SPACECRAFT MULTIBEAM ANTENNA TECHNOLOGY
J. W. Bagwell 216-433-4000
(650-60-18; 650-60-21; 650-60-22; 650-60-23)

The objective of this research is to conduct switching research

technology development on multibeam antenna system for advanced geostationary communication satellites. Efforts will be directed at applications of such antennas for multiple spot beams and scanning beams. Current efforts under this RTOP will develop proof-of-concept hardware directed at the experimental flight verification of these techniques at 30/20 GHz in 1987. Dual technology contracts are being pursued during the FY-80 to 81 time frame to accomplish this near term objective.

W82-70413 **650-60-21**
Lewis Research Center, Cleveland, Ohio.
SATELLITE SWITCHING AND PROCESSING SYSTEMS
J. W. Bagwell 216-433-4000
(650-60-18; 650-60-20; 650-60-22; 650-60-23)

The objective of this research is to develop the switching technology: for the routing of signals (traffic) aboard mutibeam, multichanel communications satellites. Currently work under this RTOP is being pursued via contracts for spacecraft switching systems for communications satellites which have been let for the design and development of breadboard models of the following subsystems: (1) switch for the trunking satellite; (2) frequency division multiple access routing assembly; (3) baseband processors; and (4) latching waveguide switch.

W82-70414 **650-60-22**
Lewis Research Center, Cleveland, Ohio.
RF COMPONENTS FOR SATELLITE COMMUNICATIONS SYSTEMS
J. W. Bagwell 216-433-4000
(650-60-23)

The objective of this research is to perform supporting research and technology development in the area of spacecraft RF components including power amplifier (tube) and solid, low noise receivers, and other transponder components. Initial effort will center on those components identified as needed in 30/20 GHz communications satellites system studies. The ranges of applicability will be determined for various component design configurations as functions of performance requirements and physical characteristics, e.g., volume, weight, power.

W82-70415 **650-60-23**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATION LABORATORY FOR TRANSPONDER DEVELOPMENT AND SATELLITE NETWORK EVALUATION
J. W. Bagwell 216-433-4000
(650-20-21; 650-20-22)

The objective of this research is to design and develop a laboratory test facility to be used to integrate and test communication system components and subsystems in a laboratory simulation of a satellite communications system. A basic three channel translation transponder will also be designed and developed. Associated test capabilities will be included in the design for use in checking out laboratory facilities. A 30/20 GHz proof-of-concept (POC) model test transponder will also be developed. A simulation of the test transponder and POC subsystem hardware will be developed to predict test results and aid in test analysis. System testing will be conducted to define the characteristics of both the complete transponder as well as individual POC subsystems. Components developed as a part of the low cost earth stations technology effort will also be evaluated. The transponder will be updated, as required, to provide a test bed for analysis and trouble shooting of flight transponders.

W82-70416 **650-60-24**
Lewis Research Center, Cleveland, Ohio.
LOW COST EARTH STATIONS TECHNOLOGY
J. W. Bagwell 216-433-4000
(650-60-18; 650-60-20; 650-60-21; 650-60-22; 650-60-23)

The objective is to perform supporting research and technology development in communications equipment required for low cost earth stations suitable for use in future Customer Premise Service (CPS) applications either fixed or mobile. This effort will develop analysis and synthesis techniques, conduct investigations, analyses, conceptual designs and evaluations of advanced communications equipment for earth stations that are capable of multiple channel duplex space communications. Major CPS ground terminal components will be selected for technology development, and by means of a contractual program, each component will be designed, fabricated and tested to a proof of concept model (POC). Complete earth stations will be assembled, tested and evaluated in order to achieve a complete earth station system characterization. Later work terrestrial/satellite mobile communcations systems.

W82-70417 **650-60-26**
Lewis Research Center, Cleveland, Ohio.
THE 30/20 GHZ WIDEBAND COMMUNICATIONS SATELLITE SYSTEM DESIGN
R. T. Gedney 216-433-4000
(650-60-16; 650-60-18; 650-60-20; 650-60-21; 650-60-23; 650-60-24; 650-60-27; 650-60-28)

The objective is to define the experimental system and services for the 30/20 GHz communications project. The approach is to award two or more system definition study contracts to define the experiment system and services to meet the 30/20 GHz communication project mission needs. The experiment system includes the flight system (communications payload and an existing spacecraft bus), a single trunking diversity station, a single customer premise service terminal, and a master control station. Services includes procurement of a solid spinning upper stage (if required), management of the STS interface, procurement of telemetry, tracking and command services, and operation and maintenance of the system for two years. Contingent upon project approval selection of one of the system definition study contractors will be made to develop the major system elements for an experimental flight. Additional efforts necessary to prepare for the experimental flight including experiment planning activities and indepth analysis in areas where further definition will assist overall program and project planning will also be conducted.

W82-70418 **650-60-27**
Lewis Research Center, Cleveland, Ohio.
BANDWIDTH CONSERVATIVE, HIGH RATE DIGITAL MODULATION TECHNIQUES
Robert E. Alexovich 216-433-4000
(541-02-12; 650-60-21)

The objective of this program is to develop spectrally efficient, high data rate, encoded digital modulation/demodulation tehniques and system components for ground and spacecraft applications. The approach is to conduct a coordinated inhouse and parallel contractual development of modulation technology through the design, fabrication, and evaluation of a modulation system breadboard. Critical system components will be developed using both existing devices and advanced high speed solid state technology. The program will provide for the selection of viable techniques from an assessment of the broad range of advanced modulation concepts which are currently being investigated.

W82-70419 **650-60-28**
Ames Research Center, Moffett Field, Calif.
DIGITAL VIDEO COMPRESSION FOR TELECONFERENCING
H. W. Jones 415-965-6616
(650-60-24)

The objectives of this RTOP are: (1) to review and report current progress in video compression; (2) to simulate; using a computer; compression techniques that are candidates for hardware implementation; (3) to fabricate a state of the art prototype video compression system; and (4) to provide documentation to allow transfer of this technology to electronics manufacturers. The approach is to first identify and test candidate compression techniques for a video compressor attaining rates of several Megabits per second and lower, and then incorporate selected techniques in a prototype compressor. The prototype compressor will provide color video at a rate of 1.5 megabits per second (Mbps) or lower and will combine spatial and temporal compression techniques. Experience has repeatedly shown that it is necessary to fully simulate the operation of a video compression system before building hardware. It has proved impossible to anticipate all the effects of a complex compression system on a variety of video material, and hardware modifications

to correct problems are much more costly than computer simulations.

Data Management

W82-70420 **656-12-02**
Goddard Space Flight Center, Greenbelt, Md.
MANAGEMENT INFORMATION SYSTEM R&D
R. S. Mitchell 301-344-8770

The objective of this RTOP is to improve general program management through application of interconnected automated offices and to develop system requirements, procure terminal equipment, operate systems, and evaluate performance. During FY-82 the study of requirements will be completed with hardware selected and ordered.

W82-70421 **656-13-02**
National Space Technology Labs., Bay Saint Louis, Miss.
APPLICATIONS OF 32-BIT MICROPROCESSOR TERMINALS
Ferrdn H. Risinger 601-494-3586

The purpose of this research and development effort is to develop a system that can be used as either a smart terminal or as a stand alone image analysis system. The smart terminals will be designed with a goal of being compatible with, and be adaptable to the Applications Data Service (ADS). The 32-bit microprocessor driven terminals will be design and built to provide the functions required by the OSTA Discipline Division Programs, ADS, and ERDANET, the Oceans Research Support, the Geodynamics Program, and the Upper Atmospheric Research Satellite (UARS) data system. The intent of this effort is to develop a hardware/software system that can be replicated from standard, off the shelf components by government or industry at a reasonably low cost. Extensive use will be made of previously developed concepts and data processing algorithms. The system will be reported and the design will be made available so that interested industrial concerns can make the system available in the marketplace as is, or as an improved version.

W82-70422 **656-13-40**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEANIC PILOT SYSTEM
E. A. Gardner 213-354-2900
(656-45-02; 656-31-02; 656-26-03)

The objectives of this activity are to: (1) evaluate, design, and implement the appropriate computer and information technologies, standards, and applicable products for an oceanic information pilot system; (2) develop a thorough understanding of the information systems needs of the OSTA oceanic research community by demonstrating developed capabilities; and (3) coordinate phases of the oceanic pilot system development with the other pilot systems, related NASA end-to-end data system (NEEDS) efforts, and the application data service (ADS) planning studies. These objectives will be pursued through the design, development, and operation of the Oceanic Pilot System. This system will provide selected researchers in the oceans remote sensing community with computerized access to satellite and conventional data sets. It will offer oceanographers state of the art facilities for data management, cataloging, access, data base sharing, data processing, and information extraction. The pilot system, possessing many of the attributes of the OSTA Data System/Applications Data Service (ADS), will serve NASA oceanic researchers in a test bed environment to support their information system requirements.

W82-70423 **656-13-50**
Lyndon B. Johnson Space Center, Houston, Tex.
ADS RESOURCES PILOT SYSTEM
Michael L. Steib 713-483-5013
(656-13-30; 656-13-40; 656-26-02)

The purpose is to define and develop a pilot data system test bed with automated data acquisition provisioning and measurement (DAPAM) and advanced data handling in a distributed environment supporting renewable earth resources applications and ADS program requirements. Other objectives are to: (1) develop functional and data management requirements for a DAPAM system, (2) expand interim manual ground data catalogs developed during FY-81; (3) evaluate FY-81 interim digital image automated status tracking system; (4) design, schedule, and begin implementation of automated DAPAM system; (5) as developed, integrate DAPAM components into Earth Resources Data Applications Network (ERDANet) between JSC and LARS at Purdue University; integrate resources pilot systems at JSC and LARS into a prototype ADS networks by upgrading and enlarging ERDANet; (7) insure capability with earth resources applications and ADS; (8) participate in the development, use, and evaluation of ADS standards; (9) set up resources pilot steering group of users and data systems experts; (10) evaluate and apply optical bar codes, touch screens, etc., to data capture; (11) interconnect resources pilot with other ADS pilots for data sharing; (12) evaluate and develop local network (4 to 20 Mbps) of intelligent work stations; and (13) evaluate developing transportable software in DOD's new Ada language.

W82-70424 **656-13-60**
Goddard Space Flight Center, Greenbelt, Md.
OCEANS DATA SYSTEM R&D
M. Banks 301-344-9420
(656-13-40; 656-44-10; 656-13-30; 656-26-02; 146-40-15)

The objectives are to perform activities necessary to define and implement a data system for the support of oceanographic and cryospheric research. This data system will emphasize the application of interactive image processing and graphics techniques for analyzing and comparing the diverse types of remote sensor, in situ, and model data used for oceans and ice studies. User requirements, both immediate and projected long range, will be identified based on the research support needs of Goddard's Oceans and Ice Branch. A data system will be designed which allows for an incremental or phased implementation of the hardware and software necessary to meet these requirements. Implementation will then begin on selected functions necessary to support research activities under the Oceanic Processes programs. The initial system will be based on the existing PDP-11/45 computer with attached image and graphics terminal. Initial data system capabilities will be provided to support research in ocean colorimetry, ocean wave spectra analysis, ice dynamics and processes, and precise altimeter profile analyses. New interactive analysis capabilities for extraction of oceans and ice information will be developed. Designs and plans will be produced for phased development of an oceans and ice analysis facility to meet the general data display and analysis requirements of the Oceanic Processes program.

W82-70425 **656-20-01**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED DATA SYSTEMS USING VLSI
Robert Nathan 213-354-2073
(656-30-01; 656-44-03; 656-13-40)

The long term objectives of this RTOP are twofold: define, design, and incorporate individualized very large scale integrated (VLSI) systems into image processing data operatins to improve the volume throughput and to assist in the ongoing rapid evolution of VLSI design tools which allow automated conversion of VLSI algorithms into wire lists for hardware fabrication. For FY-1982 the specific objectives are to: (1) establish requirements and identify potential VLSI applications for eliminating system bottlenecks in OSTA data systems; (2) simulate VLSI function with discrete hardware to perform geometric image reprojection; and (3) develop software to interface the geometric hardware to a computer. The general purpose digital computer in its present form is not able to handle the data rates and subsequent throughput requirements of data systems in the mid 80's and early 90's. In particular, vast quantities of image data will have to be calibrated, geometrically projected, mosaicked, and otherwise manipulated and merged at rates that far exceed the capacities of present systems. Implementing specific image processing algorithms via very large scale integrated (VLSI) systems offer a potent solution to this perplexing problem. Two algorithms stand

out as being particularly critical, geometric map transformation and filtering or correlation. These two functions form the basis for data calibration, registration, and mosiacking. The VLSI technology also holds similar promise for the soluton of problems in other applications. This task includes an investigation into other bottlenecks in data systems emphasizing exploration for a fast filtering machine for pilot data systems, an intercomputer bus for local networking, computation intensive modules in SAR processing, an intelligent controller for optical disk devices, and documentation functions in telemetry processing.

W82-70426 **656-20-01**
National Space Technology Labs., Bay Saint Louis, Miss.
CONVERSION OF MULTIDISCIPLINARY RESOURCE MANAGEMENT APPLICATIONS SOFTWARE FOR PROCEEDING DATA ON ARRAY PROCESSOR
R. W. Pearson 601-688-3586

The purpose of this research and development effort is to create sets of simulated thematic mapper (TM) and multilinear array (MLA) data to be used by GSFC in prelaunch checkout of the ground data processing systems for these sensors. The NSTL Gates Learjet aircraft has been equipped to fly both an airborne thematic mapper simulator (developed at NSTL/ERL) and a breadboard version of the multilinear array, also known as the LAPR (developed at the (GSFC). It is proposed that airborne sensor data be collected over selected test sites, processed to produce simulated data sets of the TM and MLA sensors with as many true sensor characteristics as is feasible. The airborne TMS, when flown at 40,000 feet altitude spatially simulatees the TM, and the seven spectral bands are as close to the bands specified for the flight hardware as is reasonably possible. Enclosure 1 gives the data band definition of the TMS. Enclosure 2 gives the sensor characteristics of the breadboard MLA (also called LAPR) and the planned flight MLA. The simulated data sets will be provided to the appropriate project offices at GSFC in digital computer compatible tape format at a packing density of 6250 characters/inch.

W82-70427 **656-26-03**
Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT AND OPERATIONAL EVALUATION OF A HIGH DATA RATE OPTICAL DISK RECORDER/ REPRODUCER SYSTEM
D. Howell 301-344-9041
(146-50-02; 656-13-30; 656-26-02; 656-20-01)

The objectives are to: (1) develop a working understanding of optical disk technology and apply it in support of the Severe Storms and Climate Research Programs to assess the benefits, limitations and overall capabilities; (2) develop optical disk applications to demonstrate the utility of and future potential for low cost mass storage devices in the area of data recording, image analysis, and permanent data base archives; (3) use the Atmospheric and Oceanographic Information Processing System (AOIPS) facility as a test bed for the evaluation and demonstration of optical disk technology in its application to OSTA data systems problems; and (4) demonstrate real time telemetry recording (Level 0) (VISSR), interactive access and manipulation of very large data sets (Levels 1 and 2) (VAS Demonstration Sounding System), and permanent data archival applications (Levels 1 through 4) (Pilot Climate Data Base Management System) and general user access through a hyperchannel network topology (Pilot Atmospheric Data System). The application of optical disk technology to support OSTA applications programs will result in significantly greater capability to handle massive image data sets as generated by such new NASA instruments as VAS and the Thematic Mapper, and future instruments based on the MLA. Significantly higher recording densities will allow for lower cost on line data archives as well. Demonstration of the capabilities to support such OSTA activities will prepare the groundwork for routine use of optical disks in future OSTA programs.

W82-70428 **656-30-01**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA REGISTRATION AND INTEGRATION RESEARCH AND DEVELOPMENT
Nevin A. Bryant 213-354-7236

This RTOP supports the Data Systems Branch objectives to develop improved capabilities and transportable software to geometrically correct and register digital images, and to register multi-source image and non-image data sets to common map projections. The research will concentrate upon improving data integration functions; particularly, the automated registration of multi-source data, integrated image and graphics systems processing, and the integration of discrete and image data types. The research approach will include the development of each data integration component at three levels: (a) analysis of the generic functions involved and assessment of the most efficient computing system configuration for each function, (b) development, testing, and documentation of transportable software, and (c) development of microcomputer based subsystems to provide efficient handling of analyst-intensive operations. Algorithm requirements will be formulated through the use of JPL staff and university consultants. Software and procedures will be coded and integrated to the JPL/VICAR image processing system and Computer Graphics Laboratory systems respectively. Developed software will be applied to selected test cases from ongoing research being undertaken for the OSTA Discipline Branches. The initial test case application will be replicated when the microcomputer systems have been developed to improve the performance of front-end editing and back-end data management functions.

W82-70429 **656-30-01**
Lyndon B. Johnson Space Center, Houston, Tex.
REGISTRATION RESEARCH
Richard D. Juday 713-483-4505

This investigation will address improvements to the JSC Registration Processor to achieve 0.2 pixel accuracy, increase the algorithm robustness, hence registration matching success rate, and accommodate sensor to sensor (Landsat MSS-to RBV, MSS-to-sensor/map) registration. Candidate edge detection and other spatial feature selection enhancements and improved image matching techniques will be investigated by comparing performance on representative image areas of interest collected from MSS, RBV, and aircraft data for other concurrent research. The MSS and RBV instrument response functions and geometric distortion characteristics will be investigated for improving the models used in geometric correction. Compensation for environmental effects such as cloud and terrain relief will be investigated for increasing accuracy and robustness. Identified improvements will be implemented in the JSC Registration Processor and the performance will be evaluated with real simulated imagery.

W82-70430 **656-30-01**
National Space Technology Labs., Bay Saint Louis, Miss.
DATA REGISTRATION AND INTEGRATION R&D
R. Pearson 601-688-3586

The NSTL's Earth Resources Laboratory has developed a geocoded information system known as ELAS. The ELAS, an acronym for earth resources laboratory applications software, accepts multisource, multitemporal data and registers it to a common map projection. The input data may be in raster, point, line, polygon, or area, and may come from LANDSAT MSS, aircraft MSS, maps, lines, polygons, areas, NCIC topographic tapes, digitized soils data, etc. Discrete data is made to register appropriately over image raster data. Digitized map data may be entered as a collection of individual cells (points) or each data type may be entered as a polygon. Once the data is stored in computer memory a variety of data manipulations may be made by special and generalized algorithms to derive information from the data. The ELAS has been developed and is a FORTRAN language operating subsystem that is easily transportable to various computers and has in fact been implemented on nine minicomputers and midicomputers as shown in enclosure 1. The thrust of this proposed effort is to improve the capabilities of ELAS by incorporating new routines that make it accept more types of input data formats, that make it register or geometrically correct data to a higher precision, and that make it reference data to a greater number of map projections. The data handling requirements of selected OSTA programs will be evaluated to determine if they can be effectively incorporated into ELAS.

W82-70431 **656-30-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA REGISTRATION AND INTEGRATION R & D
J. T. Dalton 301-344-6276
(656-20-01)

The objectives are to develop improved techniques and software to support the georeferencing, correcting, registration, and integrated analysis of multi-source and multi-temporal data. Current limitations in the overall data integration process will be addressed through three separate complementary, coordinated tasks. (1) New techniques will be investigated for identifying, parameterizing, correlating, and georeferencing image features. These techniques will be evaluated for use in geometrically correcting TM data and future high resolution imagery, such as MLA. (2) The performance of the present LANDSAT-3 system will be analyzed in terms of the sources of error in geometric processing and the sensitivity of these error sources to improvements in procedures and techniques and to sensor/platform characteristics. Selected improvements will be implemented and evaluated in the operational environment. (3) New automated techniques and high level software will be developed for the interactive display, manipulation, and management of geo-based image and non-image data. Initial development will focus on meteorological applications requiring the integrated analysis of geostationary and polar orbiter imagery, and non-image surface observations of severe storms.

W82-70432 **656-31-02**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA BASE MANAGEMENT SYSTEM (DBMS) PROTOTYPE IMPLEMENTATION & EVALUATION
Guy M. Lohman 213-354-2740
(656-13-40; 656-44-03; 656-26-03)

The goal of this effort is to demonstrate and evaluate the DBMS required to provide efficient and timely access to large OSTA data bases. A series of near-term implementations that support the Oceanic Pilot System (OPS), using commercially available DBMS software, will be performed to achieve this goal. Specific objectives for FY 1982 are to: (1) Develop and test methods for structuring an integrated scientific data base to speed user access; (2) Establish an in situ data base using available JASIN, sea-level station, and other available in situ data sets relevant to OPS; (3) Establish a DBMS-based image catalog for OPS that indexes SEASAT VIRR, Tiros AVHRR, and NIMBUS CZCS images; and (4) Demonstrate and measure the access and storage savings from the application of advanced adaptive data compression techniques. Both the in situ data base and the image catalog will use a commercially available DBMS for the OPS DEC VAX 11/780. These will be developed as stand-alone data bases in parallel with the implementation of the OPS satellite data archive. Emphasis will be placed on early implementation of both data bases as interactive prototypes having access keys such as time, location, spacecraft, sensor, and geophysical parameter. Tests will be conducted in collaboration with OPS oceanographers to evaluate the effectiveness of the data base structure. Feedback from these evaluations will be used to refine the DBMS data structure so that it is optimum from the user interface perspective. Engineering tests will also be conducted to evaluate the overall performance of the DBMS, including access time, storage volume, and time to program new outputs.

W82-70433 **656-44-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SAR DATA SYSTEM RESEARCH AND DEVELOPMENT
Chialin Wu 213-354-2061
(506-61-25)

The overall objective of this RTOP is to develop, evaluate, and demonstrate end-to-end data system concepts and data processing techniques to facilitate and automate transmission, processing, storage, and analysis of data gathered by future spaceborne synthetic aperture radar (SAR) sensors. Five major subtasks in this RTOP are as follows: (1) end-to-end data system study; (2) SAR data transmission subsystem development; (3) spaceborne SAR correlation research; (4) interim digital SAR processor upgrade and extension; and (5) SAR post-correlation system analysis and development. The first subtask performs the system engineering work for the overall SAR data system. This subtask will perform system analysis and tradeoff studies to develop and document the functional performance requirements and the associated functional design for an end-to-end SAR data system. Development and demonstration of the basic techniqus used in data handling subsystems will start in FY-82. Advanced development which will be performed in FY-83 and beyond will conform with the requirements provided by subtask (1). The second subtask is aiming toward the design and development of accurate and automatic SAR data transmission techniques to link data handling subsystems and to interface SAR sensor with image application users. The third subtask performs SAR correlation research which addresses several unique problems associated with the SAR instruments operated in C and X frequency bands and in burst transmission mode. The fourth subtask designs and upgrades the interim digital SAR processor (IDP) using advanced hardware and software techniques, and demonstrates the capability of processing shuttle imaging radar (SIR) imagery using correlation algorithms developed in the third subtask. The fifth subtask deals with SAR unique image radiometric and geometric correction schemes; so that the SAR data products can readily be used for application studies.

Geodynamics

W82-70434 **676-30-05**
Jet Propulsion Laboratory, Pasadena, Calif.
LITHOSPHERIC STRUCTURE AND EVOLUTION
Stephen F. Daly 213-354-2046

This proposal consists of two separate tasks: (1) Mantle convection studies; work will be continued on understanding implications for the evolution and structure of the lithosphere due to penetrative convection in regions of high viscosity gradients; gravity and surface displacement will be calculated using high resolution grids; layered convection will be studied using analytical and numerical techniques; three dimensional models with a moving lithosphere and subducting slab utilizing a mean field approximation in the third dimension will be developed to study convection and its surface signature, and (2) Earth core effects; the proposed research includes: a study of variations in the magnetic field and gravity anomalies in the fluid core to determine their effect on Earth rotation and wobble; continued study of the Laplace ocean tidal models; and a study of the effects of diurnal and semi-diurnal meteorology (in particular, the radiational tides on the Earth's gravity field).

W82-70435 **676-59-31**
Jet Propulsion Laboratory, Pasadena, Calif.
SERIES - SATELLITE EMISSION RANGE INFERRED EARTH SURVEYING
P. F. MacDoran 213-354-7118

The objectives are to conduct demonstrations of the feasibility of using the Global Positioning System (GPS) satellites radio emissions in a differential one way ranging configuration which will provide a delay data type identical to radio interferometric techniques with the advantage of a 1000 to 1 data compression over the previous interferometry mode. The specific items to be demonstrated are SERIES instrumental inherent stability and accuracy, independent station mobility, accuracy of differential ionospheric calibration, and the ability to measure baselines with few cm precision. In the original SERIES implementation, the GPS was to serve as an incoherent noise like illuminator of an earth based interferometer. As is the case with all radio tracking systems, the ionosphere represents an error source which requires specific calibration, either by modelling or by direct measurement. The SERIES was originally designed to acquire identical data at the two transmitted bands L1 and L2, detect signals by cross correlating noise like signals from two stations at each band, forming delays from each band and then differencing the L1 and L2 delays to extract the differential ionospheric delay in each interferometer path. A challenge noted in that design concerned the ability to simultaneously estimate ionospheric

effects and baseline errors using the largest spanned bandwidth possible (348 MHz) in order to achieve the required delay precision although ambiguous at 86 cm intervals.

W82-70436 **676-59-33**
Marshall Space Flight Center, Huntsville, Ala.
SUPERCONDUCTING GRAVITY GRADIOMETER
E. W. Urban 205-453-5132

The objective of this RTOP is to demonstrate the feasibility of a three axis superconducting gravity gradiometer for space flight that is capable of measuring gravity gradients along three mutually perpendicular axes with a sensitivity of 0.01 EU or better. A single axis unit will be completed and tested and a three axis engineering unit will be designed, fabricated, tested, and refurbished for a possible shutte test flight.

Resource Observations Applied Research and Data Analysis

W82-70437 **677-21-21**
National Space Technology Labs., Bay Saint Louis, Miss.
MULTISENSOR LAND RESOURCES STUDIES
A. T. Joyce 601-688-3830
(677-21-23)

The overall objectives are: (1) to gain a basic understanding of the spectral characteristics of various surface conditions associated with each land cover type, (2) to determine the influence of these characteristics on specific regions of the electromagnetic spectrum, particularly the mid and thermal IR, and microwave regions, and (3) to use this knowledge for the development of techniques oriented at the extraction of information pertinent to specific applications. Two applications for which techniques will be developed in FY-1982 are: (1) surface mine rehabilitation and monitoring and (2) semi-arid rangeland degradation monitoring. Remotely sensed data utilized in this project will be acquired by spacecraft (LANDSAT multispectral scanner and thematic mapper, SEASAT and shuttle synthetic aperture radar) and aircraft (thematic mapper simulator and thermal infrared multichannel scanner).

W82-70438 **677-21-22**
Ames Research Center, Moffett Field, Calif.
ALASKA WETLANDS DELINEATION PROGRAM
D. E. Wilson 415-965-5897

The purpose of this RTOP is to develop, evaluate, and document a technique which utilizes LANDSAT data for distinguishing wetlands from nonwetlands cover types in Alaska. The project objective will be met utilizing the following approach. First, a LANDSAT scene will be analyzed to provide a land cover map of the selected wetlands test site. Concurrent with this effort, a randomly selected set of points will be used to locate homogeneous areas of land cover to be identified by photographic interpretation of color infrared photography. These points will then be field checked and used as an evaluation of the LANDSAT digital analysis. Ancillary data sets including landform, surficial geology, soils, permafrost, etc., will be digitized and registered to the LANDSAT land cover map. These combined data sets will then be used to refine the wetlands delineation done on the basis of land cover only. The resulting wetlands delineations will then be evaluated to determine which data sets when combined with the land cover map result in the best wetlands delineation.

W82-70439 **677-21-23**
Ames Research Center, Moffett Field, Calif.
REMOTE SENSING STUDY OF SOILS IN CALIFORNIA
R. C. Wrigley 415-965-6060

The objective of this work is to develop remote sensing techniques for the delineation of soils using the spectral regions employed in the Thematic Mapper (TM) (particularly the 1.6 micron, 2.2 micron, and thermal bands). Involvement with the Soil Conservation Service (SCS) in California will aid in determining the applicability of remote sensing techniques to current soil survey and mapping methods. TM simulator data from the modified Daedalus scanner will be acquired over agricultural areas when fields are most likely to be bare and over wildland areas before the natural grasses senesce. Image analysis techniques using various combinations of bands will be employed to bring out soil delineations in conjunction with ground data. Several approaches will be employed in the acquisition of ground data: (1) intensive monitoring of three large agricultural fields with a range of soil types during overflights; (2) detailed studies of natural grassland areas also during overflights; (3) use of recent SCS soil maps augmented with limited additional ground data in conjunction with regular activities of the SCS and California Department of Water Resources. The variety of ground data will permit both intensive and extensive approaches to the problem: the intensive work will build a solid information base on specific areas while the extensive work will examine large areas synoptically.

W82-70440 **677-21-24**
Ames Research Center, Moffett Field, Calif.
THEMATIC MAPPER SIMULATOR LAND RESOURCES STUDIES IN WESTERN ECOZONES
D. Sinnott 415-965-5897
(677-21-26)

The primary objective of this RTOP is to assess the contribution that forthcoming thematic mapper (TM) data can make to land resources studies by evaluating the impact of thematic mapper simulator (TMS) data on resource identification and classification accuracy of thematic maps in unique western forest, urban, and agricultural ecozones. Subobjectives include: quantitatively assess the spectral and spatial content of TMS and LANDSAT multispectral scanner (MSS) data; develop, test, and document computer software for selecting optimum subsets of TMS spectral bands for specific resource mapping tasks; determine the adequacy of per-point classifiers for use in TMS studies; and evaluate design implications for new contextural classifiers. The following approach will be utilized. Initially, TMS data will be acquired for forest, urban, and agricultural regions in Santa Cruz and Fresno Counties. Classification accuracy will be evaluated as a function of sensors, the classification analysis process employed and the level of thematic information extracted. Existing clustering and classification algorithms from in-hand software systems will be evaluated in terms of their ability to handle TMS data. Both the spectral and spatial information content of TMS data will be assessed using greytone value, textural transforms, and separation statistics. A technique for selecting optimal TMS waveband combinations will be developed using statistical separabilities. Finally, texture measures will be employed to investigate design implications for adapted classifiers.

W82-70441 **677-21-24**
Goddard Space Flight Center, Greenbelt, Md.
TMS AND AVHRR LAND RESOURCES STUDIES
D. L. Williams 301-344-8860

This research project is designed to examine the utility of the thematic mapper simulator (TMS), active microwave sensors, and the AVHRR for land resources inventory and assessment. In addition, contextual classifiers will be evaluated for the purpose of classifying high resolution remotely sensed imagery such as the TMS. The activities of this RTOP will be divided into four tasks which will address component parts of the overall objective. These tasks are: (1) quantitatively determine the utility of the thematic mapper (TM) for land resources studies; (2) evaluate suburban/urban spectral, spatial, and temporal phenomena which should be taken into account for the design of future sensor systems and urban area classification; (3) develop and apply methodology to classify high resolution remotely sensed imagery such as TMS on the basis of contextual features; and (4) assess utility of a very high resolution radiometer (AVHRR) for monitoring large scale land use change in tropical areas. This project will focus remote sensing research and technique development on obtaining accurate land resources information from current and future satellite systems. The results of this RTOP will help to provide useful data to government agencies, and public and private concerns for their land resources management responsibilities.

W82-70442 **677-21-25**
Jet Propulsion Laboratory, Pasadena, Calif.
LAND RESOURCES MODELLING AND LAND COVER SAR ANALYSIS
Nevin A. Bryant 213-354-7236

It is the purpose of this task to advance the state-of-the-art of resource management analysis and planning activities by developing software and procedures that integrate and interpret a variety of remotely sensed data types (visible, SWIR, synthetic aperture radar (SAR) and collateral data with models to analyze land cover and predict change in a region. It is expected that the products of this research will help NASA focus upon the more pertinent parameter requirements for geometric and classification accuracy on future missions and associated SRT areas in land resources. Improvements in our capability to map and integrate remotely sensed data into land resources modelling will be pursued by: (1) developing in FY-80 and 81 procedures and software which integrate remotely sensed data with other collateral data into models which assess and/or predict potential land capability or productivity under varying constraints to land use; (2) developing in FY-81 and supporting in FY-82 the analysis of research data sets of the Los Angeles area composed of registered multi-frequency, multi-temporal and multi-sensor data sets in conjunction with National Science Foundation research sponsorship; (3) continuing the analysis of SAR responses to land cover mapping by incorporating scatterometer measurements and modelling reflectance properties of Los Angeles area urban and near-urban land cover types; (4) developing software and procedures for predicting land use change based upon the principles of Markov processes and cellular transformations; (5) developing algorithms and procedures for data base segmentation techniques, which add spatial coherence to the process of information extraction for land cover mapping. Each of the development areas will make use of airborne, high-resolution digital data where available, particularly Thematic Mapper Simulator and L- and X- Band SAR data. Emphasis will be upon the integration of the future satellite image simulations and ancillary data to test the improvement potential for land resources mapping.

W82-70443 **677-22-08**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF SOIL MOISTURE FOR WATER RESOURCES
T. Schmugge 301-344-6059

This RTOP will develop techniques for remotely measuring soil moisture with application to water resources management problems. The specific goals are to test the use of L-Band Passive Microwave and Thermal Infrared remote measurements to determine if subsurface effects can be separated from surface soil moisture effects; and develop techniques for evapotranspiration estimation using remote sensing data. A 21 cm radiometer will be flown over specified flightlines of hydrologic interest on a repetitive basis. Correlation analysis among the lines will be performed to identify surface soil moisture effects, depth to groundwater, and precipitation variation. Thermal and microwave data from A/C and spacecraft will be input to energy balance models for estimations of local and regional evapotranspiration (ET). A preliminary estimate of the effectiveness of remotely sensed soil moisture data for runoff prediction, ET determination and estimation of subsurface hydrologic features will be made. An evaluation of the utility of repetitive remote sensor data for hydrologic applications will be performed.

W82-70444 **677-22-12**
Ames Research Center, Moffett Field, Calif.
REMOTELY-SENSED ELECTROMAGNETIC CHARACTERISTICS OF SNOW AND SOIL MOISTURE
W. I. Linlor 415-965-5538

The long range objective of this activity is the development of microwave remote sensing techniques for the measurement of the areal extent, depth, density, and wetness of snowpacks, employing surface systems, aircraft, and satellites. Such information is needed to assess snowpack mass and runoff regimes for better utilization of water resources, hydroelectric energy production, and for flood forecasting. The immediate objectives of this RTOP include investigation of the electromagnetic characteristics of natural snowpacks (dielectric constant, attenuation, and layering), radar backscatter properties, and development of surface systems to provide ground truth data. The surface systems have the additional objectives of providing data for assessment of watershed resources on a time-progressive basis, operated automatically in data-collection-platform installations, including measurement of soil moisture utilizing microwave techniques. The approach consists of measuring the phase shift and attenuation as functions of frequency in the range of 2 to 18 GHz, for in-situ snow and for samples. Radar backscatter is investigated as functions of frequency, angle of incidence, polarization, and snow layering. Calibration involves the use of dry snow to which known amounts of water have been added.

W82-70445 **677-22-26**
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF SNOWPACK PROPERTIES
A. Rango 301-344-5480

Snowmelt runoff modeling and snowpack properties measurement and data processing and analysis will be conducted in support of U.S.A./Japan joint snow project. The use of satellite data for improved snowmelt runoff prediction in foreign areas will be evaluated. The U.S. and Japanese snowmelt models will be run using available data. Truck, aircraft, and satellite microwave data will be processed, analyzed, and exchanged in the joint snow study. Various types of visible/IR satellite data will be used to feed snowmelt runoff prediction models with computed flow evaluated against actual streamflow. The Japanese snowmelt model will be evaluated on the GSFC system and Japanese ground truth and satellite data will be evaluated at the GSFC. The snowmelt model will be evaluated on a variety of test basins and widespread applicability tested.

W82-70446 **677-26-14**
Goddard Space Flight Center, Greenbelt, Md.
IMAGE REGISTRATION SYSTEMS STUDY
W. R. Case 301-344-8963
(656-20-01; 656-30-01; 677-27-01)

The overall objective of the tasks described herein is to perform a systems study of advanced high resolution earth observing instruments to define areas for improving image registration accuracy. In particular, the study is to be a total system study, focusing on tradeoffs between the flight segment and ground segment in order to obtain the registration accuracy required of future advanced imaging sensors. The approach will be to define three strawmen models of advanced earth observation instruments, together with their science requirements, that contain key elements which drive registration technology. Of these three strawmen, one will be the Multispectral Linear Array intrument. Using these strawmen models; techniques for obtaining that required registration accuracy will be investigated which make the best use of both the flight and ground processing segments. Tradeoffs between onboard processing, onboard active compensation, and ground processing will be performed in order to identify optimum methods for obtaining the required registration accuracy considering data accuracy, cost, and data delivery times. The expected result will be identification of alternative, techniques for improving registration accuracy of advanced high resolution earth observing instruments making use of both the flight and ground segments.

W82-70447 **677-27-12**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECTROMETER CALIBRATION AND SAR
W. E. Brown 213-354-2110

This RTOP covers the spectrometer dvelopment and the digital processing of a limited amount of SEASAT images in support of renewable resources investigators. The ultimate objective is to develop a radar spectrometer that will cover the range of 0.3 to 30 GHz. In FY-82 we will demonstrate the operations over the range of 2 to 18 GHz and conduct field measurements jointly with E. Njoku and establish a calibration procedure with Kansas and others. Cross polarized echo amplitude and phase measurement capability will be added in FY 83 to 84. Seasat synthetic aperture radar (SAR) imagery of selected areas

will be digitally correlated. In FY-82, the spectrometer will be made operational with the dual antennas and frequency modulation. Field tests will be conducted with E. Njoku and calibration measurements with F. Ulably at U. of Kansas. Studies pertaining to (1) adding a longer boom, (2) adding polarization, and (3) other possible platforms will be conducted. The implementation of these additions will be proposed for FY-83 to 84.

W82-70448 **677-27-14**
National Space Technology Labs., Bay Saint Louis, Miss.
TMS PROCESSOR UPGRADE DEVELOPMENT
Ferron H. Risinger 601-688-3586
(677-80-20)

The National Scientific and Technical Laboratory's Earth Resources Laboratory (NSTL/ERL) developed a system for reading pulse code modulated data (PCM) from 1 inch wide instrumentation tape and converting it from PCM format to non-return-to-zero format required by conventional computers in CY-71. The system was upgraded slightly in 1974 and again in 1976, but some components in the system are getting quite old, and need to be upgraded to make the system more reliable and to add capabilities that will enable the system to support current and future planned requirements. The system's CY-71 model tape reproducer will be replaced, the EMR bit synchronizers will be refurbished, a CRT display device will be provided, a quick look film recording device will be added, a switching mechanism will be added to insure that the preprocessor will be supported by either of two modern computers to increase reliability, and a modest capability will be incorporated to perform quality hecks on the Thematic Mapping Simulator data.

W82-70449 **677-29-05**
Goddard Space Flight Center, Greenbelt, Md.
SOIL/SNOW MOISTURE RESEARCH AND ASSESSMENT MISSION STUDY
Fran Stetina 301-344-7496

The object of this RTOP is to define mission requirements, instrument options, and feasible system concepts for a soil/snow moisture research and assessment mission. An application working group will be formed to define the requirements for satellite remote sensing measurements of soil and snow moisture. A study of various instrument options that are responsive to those measurement requirements will then be made to form the basis of the study of feasible system concepts. The results of these system concept studies will be iterated with the working group to assure compliance with the requirements. The need, if any, for new technology to support the mission will be evaluated. Such a mission will support the water resources, agriculture, and climate research programs of NASA and other agencies. User needs, mission requirements, instrument configurations, system concepts, and required new technology will be documented.

W82-70450 **677-29-12**
Jet Propulsion Laboratory, Pasadena, Calif.
DIGITAL TOPOGRAPHIC MAPPING MISSION - REQUIREMENTS/FEASIBILITY STUDY
Michael Kobrick 213-354-4631

The overall objectives are a determination of the requirements for digital topographic mapping of the Earth, and an assessment of the feasibility of accomplishing this during an orbital mission. The attempt to meet these objectives will proceed along three main complementary lines. A Users Working Group (UWG), comprised of individuals representing a cross section of universities, industrial and government agencies, will be formed to develop a set of requirements for a digital topographic mapping mission. This group will specify scientific requirements such as horizontal and vertical resolution, swath width or areal coverage, percentage of worldwide coverage, identification of high priority targets, overlap with LANDSAT/other data bases, data products and data processing and distribution. An evaluation of the various sensors and techniques available for digital mapping will be performed. These include, but are not limited to photographic stereo, synthetic aperture radar stereo, radar photo hybrid, radar altimetry, and scanning laser altimetry. Error and efficiency analyses will be performed for each of these, and technology requirements will be identified. In light of the recommendations of the UWG and technical results of the sensor studies, a candidate design for a first topographic mapping mission will be identified. The parameters to be specified in this design include; sensor type and configuration (including resolution, swath, and coverage), orbit parameters, mission length, data processing and product requirements, orbital platform, and the implementation of a data processing and distribution system.

W82-70451 **677-29-14**
Jet Propulsion Laboratory, Pasadena, Calif.
SHUTTLE GEOLOGY MISSION REQUIREMENTS STUDY
Alden A. Loomis 213-354-6629

The objectives of this study are to: (1) define a concept for utilizing advanced sensor systems on shuttle missions for geological investigations; (2) define a set of synergistic instrument complements to satisfy a set of user reqirements for selected experimental missions; and (3) determine the mission requirements. The approach will involve forming an informal working group made up of potential investigators. This group will identify experiments and requirements for data acquisition, identify sensors, and establish mission requirements such as length of stay, inclination, lighting conditions, and others. Attention will be paid to integrating data acquired by free-flyers such as LANDSAT with the shuttle complement. The mission and data acquisition concepts and instrument complements will consider the potential for partial funding by elements of the private sector.

W82-70452 **677-29-16**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACELAB MISSION REQUIREMENTS STUDY
Deborah G. Vane 213-354-7272

The objectives of this study are to: (1) identify the mission parameters required by the resource observation sensors and instruments under development, or planned for development, for flight on Shuttle/Spacelab missions and identify the associated optimum mission parameters; and (2) identify what could be accomplished by each of these instruments on shared flights at inclinations of 28.5 deg, 56 deg, and near-polar launches. The approach will involve first conducting a survey of sensors/instruments planned for flight on Shuttle/Spacelab missions and identifying their technical characteristics and scientific objectives. Following this survey, the optimum mission parameters for each instrument/sensor will be identified. Analyses will be conducted to determine the trade-offs between various flight parameters and instrument/sensor objectives and characteristics, leading to an assessment of the impact of nonoptimum mission parameters. For Shuttle missions at orbital inclinations of 28.5 deg, 56 deg, and near-polar launches, each instrument/sensor will be assessed for the usefulness of acquired data. Finally, recommendations will be made regarding the composition of optimum payload complements.

W82-70453 **677-29-22**
Jet Propulsion Laboratory, Pasadena, Calif.
LUMINESCENCE DETECTOR -- FEASIBILITY/CONCEPTUAL DESIGN
J. B. Breckinridge 213-354-6785

The purpose of this research is to determine if a technique based on luminescence in the Fraunhofer lines is useful for distinguishing earth surface materials from orbital distances, and to develop a conceptual design for an optical system for remote sensing of luminescence using the Fraunhofer lines. Building on the framework established by ground based and aircraft research, and in consultation with established leaders in the field of solar-stimulated luminescence the feasibility for remote passive sensing from orbit of solar stimulated luminescence on the earth will be examined. Specific conditions to optimize detection and measurement will be identified for several sensor system design approaches, under a variety of environmental and general atmospheric conditions. Considerable attention will be given to the suitability of the design approach used by existing successful aircraft instruments for remote sensing from orbit.

W82-70454 **677-29-23**
Wallops Flight Center, Wallops Island, Va.
LONG WAVELENGTH SUBSURFACE SOUNDER-FEASIBILITY/CONCEPTUAL DESIGN
J. D. Oberholtzer 804-824-3411

The objective of this RTOP is the development of an electromagnetic capable of geological subsurface sounding from orbital altitude. The requirements, concepts, and critical technologies must be defined for this development. The approach for accomplishing the objective of this RTOP contains a number of steps. They include the establishment of a science and technology advisory group to develop realistic goals for subsurface sounding, the identification of the requirements for an instrumentation system that would meet these goals with the detector at orbital altitude; the determination of the feasibility of constructing the needed system, and finally the development of a conceptual design for such a system. During the course of this RTOP as the technological barriers appear that limit the development of this system, the critical needs for further research and development will be identified. The primary technique for sounding to be investigated depends for its depth measurements on the variation of signal penetration with frequency. A multifrequency electromagnetic signal is sent out and the signal scattered back into the detector is analyzed to provide subsurface structure.

W82-70455 **677-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
IMPROVED ROCK TYPE DISCRIMINATION
Alan R. Gillespie 213-354-6927
(677-41-16; 677-41-77; 677-41-04; 677-41-14; 677-41-07)

The objective of this program is to develop an improved capability to discriminate among rock materials (rocks and rock weathering products, including soils) using remote sensing techniques to infer composition, mineralogy, and lithology from spectral reflectance and emittance properties. The approach is to acquire data in the laboratory, in situ on the ground, from aircraft, and from satellites. Measurements will be made in the 0.4 to 14 micron region of the electromagnetic spectrum. Based on information derived from these data combined with knowledge of the physics of the interaction of electromagnetic radiation with geological materials, remote sensing instruments will be designed, built, and tested. Existing field instruments will be refurbished and upgraded. Using these instruments, a continuing effort will be made to determine the influence of variable environmental conditions (e.g., soil moisture, vegetation, atmospheric water vapor) upon remotely sensed data. Trade-offs among spatial resolution, spectral resolution, and radiometric precision will be evaluated in terms of effects on discriminability of common rock types. Data analysis techniques will be developed as required. Specific areas to be studied include: (1) visible-near infrared and short wavelength infrared reflectance data of moderate spectral resolution, with emphasis on geologic applications of the Thematic Mapper; (2) mid infrared spectral data, using laboratory and field instruments to determine the separability of silicates, carbonates, other rocks and rock weathering products, and vegetation; (3) thermal inertia of geologic materials as determined from aircraft, Heat Capacity Mapping Mission, and field instrument data, with continued improvement of modeling techniques; (4) data analysis and handling techniques, including completion of a large spectral data base containing many thousands of previously obtained laboratory and field spectra, and development of methods of extracting the significant information from large multispectral data sets.

W82-70456 **677-41-04**
Jet Propulsion Laboratory, Pasadena, Calif.
IMAGING RADAR GEOLOGY
Charles Elachi 213-354-5673

The Seasat SAR was the first sensor which provided synoptic radar of the Earth's surface from space. The Seasat data was acquired mainly over northern America with a 20 deg incidence angle. The SIR-A, scheduled to be flown in the fall of 1981 will provide images at a more favorable incidence angle of 50 deg and over a wide variety of geological provinces all around the world. The objectives of this RTOP are: (1) to analyze the data from the two missions to determine the role of spaceborne radar systems in geologic mapping (this includes developing the techniques to understand the radar signature of different surface units and features, and to analyze radar data in conjunction with other sensors; and (2) to conduct research on determining the effects of the radar parameters (frequency, polarization incidence angle, etc...) on the information content in the radar images. This proposal covers all the basic research effort at JPL in the area of radar geology for the three-year period of FY-81, '82 and '83. It represents the efforts of a team of nine researchers (7 professionals, 2 graduate students) who will be addressing different aspects of the radar geology activity with the common objective of understanding the information in radar images and developing techniques to use them, in conjunction with other remote sensing data, to further the understanding of the Earth's surface geology.

W82-70457 **677-41-13**
National Space Technology Labs., Bay Saint Louis, Miss.
USE OF THEMATIC MAPPER SIMULATOR FOR GEOLOGICAL MAPPING
D. Rickman 601-688-3830
(677-42-04)

Th objective of this RTOP is to develop and evaluate practical techniques for using Thematic Mapper Simulator (TMS) and other air- and spaceborne systems for geologic mapping. The emphasis will be on ore-bearing terraines under a wide variety of vegetation and topographic conditions. With this will be efforts to create a system able to readily incorporate and manipulate other geologic data bases. Thematic Mapper Simulator data will be acquired over sites exibiting a diversity of terraines, ore types, vegetative cover, and topographic relief. Included will be simpler areas in which to develop and test algorithms. Areas of known economic significance, normally complex geologic situations, will provide sites to demonstrate the usefulness and limitation of the methods as applied to areas of interest to the mining industry. Other remotely sensed data, for example from the Thermal Infrared Multispectral Scanner will be incorporated when available. Cooperation with industry and public agencies will provide much of the geologic mapping, geochemical information and other data bases necessary. Processing will follow several interrelated approaches including statistically based manipulations, data corrections, an image enhancement image interpretations. Algorithms will be developed to use or suppress topographic effects as needed. Methods to incorporate scattered point data, such as geochemical survey results, will also be created.

W82-70458 **677-41-14**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH SPECTRAL RESOLUTION TECHNIQUES FOR GEOLOGIC MAPPING
Anne B. Kahle 213-354-7265
(677-41-03; 677-41-77)

This proposal addresses one part of a continuing program at JPL to advance the state-of-the-art in geologic remote sensing. The overall objective of this proposal is to develop methods of discriminating and indentifying geological materials on the base of their composition, mineralogy, and lithology through the use of narrow-band multspectral remote sensing measurements in the visible and infrared wavelength regions of the electromagnetic spectrum. Two aircraft instruments are currently under construction for this purpose; the airborne imaging spectrometer (AIS), a 32 x 32 detector array system which will operate at high spectral resolution (lambda/delta lambda) 160 in the 1.0 to 2.5 micron wavelength region; and array system which will operate at high spectral resolution lambda/delta lambda 160 in the 1.0 to 2.5 micron wavelength region; and the thermal infrared multispectral scanner (TIMS), a 6 channel optomechanical imaging spectrometer which will operate in the 8 to 12 micron wavelength region. This proposal is to develop the capability of utilizing these instruments from aircraft platforms by: (1) completing construction of the AIS, and adapt it to fly in the JPL Queenaire; (2) conducting ground-based experimentation utilizing the TIMS which later will be operated on board the NSTL Lear jet; (3) establishing a capability to routinely reduce and analyze data obtained by the AIS and TIMS systems; obtaining experimental AIS and TIMS data over selected test sites; and (5) conducting initial analysis

of aerial AIS and TIMS data, comparing narrowband aerial multispectral measurements with narrowband ground-based measurements obtained with the portable field reflectance spectrometer, the hand held rationing radiometer, and the portable field emission spectrometer.

W82-70459 **677-41-16**
Jet Propulsion Laboratory, Pasadena, Calif.
OIL AND GAS TEST CASE STUDY
Harold R. Lang 213-354-3440
(677-41-03; 677-41-14; 677-41-18; 677-41-04; 677-48-03; 677-80-19)

The primary objectives are to: (1) demonstrate that useful information for geologic mapping can be obtained through the analysis of data acquired by state-of-the-art remote sensing techniques; (2) evaluate the utility of current remote sensing technology for geologic mapping of a known oil and gas occurrence characterized by hydrocarbon seepage; and (3) develop recommendations for the design of aircraft/spacecraft remote sensing systems that could supply data to meet the information requirements of economic geologists involved in oil and gas exploration. The general approach is to continue the ongoing investigation of the Lost River, West Virginia test site. An enlarged, regional study will be conducted of the Valey and Ridge Province (the so called 'Eastern Overthrust Belt') to identify cross strike structural discontinuities which may have a controlling influence on the surface expression of underlying oil and as reservoirs. Detailed geobotanical studies will be conducted within the test site for the purposes of enhanced geologic mapping and the evaluation of potential seepage detection. An investigation of oil and gas seepage phenomena associated with the Pico anticline oil and gas field area of southern California will be initiated.

W82-70460 **677-41-18**
Jet Propulsion Laboratory, Pasadena, Calif.
REFLECTANCE PROPERTIES OF URANIFEROUS ROCKS
James E. Conel 213-354-4516

The principal objective of this program is to obtain reflectance data for samples of alteration with uranium deposits. The samples are to be a representative collection of specimens from the suite gathered by J. Gabelman (Utah International) from world wide sources, and representing diverse occurrences of mineralization. The specimens have well documented modes of field occurrence including in many cases photographic outcrops, and have been stored since collection in a marine preserving condition in a reasonable way. Another objective of the program is to analyze the spectral information for characteristics unique to uranium associated alteration alone. Statistical studies will be made in an attempt to define groupings within the collection, and in an attempt to separate uranium associated alteration from other types of metalization alteration. Relations between spectral properties and bulk and trace elemental chemistry will be sought where availability of chemical information permits. These specimens have been carefully collected and documented by Dr. John Gabelman, Utah International, with whom the project will be carrid on jointly. Dr. Gabelman's field notes and photographs, existing and supplemental chemical data and size fractioned specimens will be used. The existing chemical data will be supplemented where possible by X-ray diffraction studies of mineralogy and analyses of trace metal content. It is expected that chemical data will be available for only a portion of the collection, but an attempt will be made to provide a representation data set. The spectral data will be recorded digitally at high spectral resolution using JPL's Beckman 5240 spectrophotometer. The wavelength region of study is 0.4 to 2.5 microns. Existing modification of this instrument permits analysis of uncovered powdered samples, and digital recording permits computer reduction and analysis of larger spectral collections using standard statistical software packages that are available at JPL.

W82-70461 **677-41-77**
Jet Propulsion Laboratory, Pasadena, Calif.
CHROMITE-MOLYBDENUM TEST CASE STUDY
Michael J. Abrams 213-354-6927
(677-42-05; 677-41-03; 677-41-14)

The primary objective is to evaluate the utility of current remote sensing technology for geologic mapping in areas of known mineral deposits. The first two types of deposits which will be examined are porphyry molybdenum and ultramatic associated chromite and nickel deposits. Other objectives are to: (1) demonstrate that useful information for geological mapping can be obtained through the analysis of data acquired by stated of the are remote sensing techniques; (2) develop recommendations for future aircraft and satellite remote sensing systems which are designed to provide useful information for nonrenewable resource exploration. The approach to be used is to establish the technical rational for specific test case studies based on: (1) current understanding of the utility of remote sensing methods; (2) models of mineral occurrence; (3) the results of earlier test case projects and other projects. A phase multiyear plan will be developed for the investigation of one or more porphyry molybdenum deposits andone or more chromite-nickel occurrences. The plan will involve formation of study teams drawn from members of industry, government agencies, and academia; identification of test sites; selection of appropriate remote sensing data to acquire; on site investigations; data interpretation and analysis.

W82-70462 **677-42-04**
National Space Technology Labs., Bay Saint Louis, Miss.
USE OF THEMATIC MAPPER SIMULATOR FOR GEOBOTANICAL MAPPING
W. G. Cibula 601-688-3830
(677-41-13)

The objective of this RTOP is to develop and evaluate practical techniques for using the Thematic Mapping Simulator (TMS) and other air and space borne systems for geobotanical mapping. The emphasis will be on ore bearing terrains in areas which are moderately to heavily vegetated. This data will be integrated into a data base system which will be capable of incorporating and manipulating other types of terrain and geologic data. Processing will follow several interrelated approaches including the development of spectral pattern recognition; additional emphasis will be placed on techniques which will aid in enhanced image interpretations. Algorithms will be developed to use or suppress topographic effects as needed. Methods to incorporate scattered point data into a data base, such as geochemical survey results, will also be created.

W82-70463 **677-42-05**
Ames Research Center, Moffett Field, Calif.
CHROMITE TEST CASE: GEOBOTANICAL MAPPING
D. A. Mouat 415-965-5897
(677-41-77; 677-42-01; 677-42-04)

The primary objective of this RTOP is to develop and evaluate remote sensing techniques to discriminate parent materials associated with known chromite deposits using vegetation characteristics. These techniques are needed to improve rock type discrimination and mineral exploration. Immediate objectives include an assessment os sensors, analytical techniques, appropriae vegetation parameters, and the degree to which selected terrain features can improve vegetation based techniques. An accuracy and efficiency comparison will be performed. The approach will consist of several facets. A study area and test sites will be selected so as to include chromium bearing ultramafic rocks from the western belts of the Klamath Mountains in SW Oregon and NW California. The vegetation and terrain features will be examined and described in order to discriminate those parent materials. Aerial photography and thematic mapper simulator data will be acquired over the test sites at appropriate dates. Several analytical techniques (including scene classification) will be employed in the data reduction phase. Terrain information will be integrated with vegetation information in a geobased information system. Appropriate techniques will be tested using test sites in similar geologic environments.

W82-70464 **677-43-13**
National Space Technology Labs., Bay Saint Louis, Miss.
GEOPHYSICAL PILOT PROJECT
B. H. Atwell 601-688-3830

This work is proposed as a first step toward developing

capabilities at the Earth Resources Laboratory for geophysical studies using space acquired data in conjunction with conventional measurements. Initial efforts are planned to be directed toward the reduction and analysis of Magsat data over the Caribbean area and planning for the synthesis of the data with other forms of data in subsequent years.

W82-70465 **677-45-06**
Goddard Space Flight Center, Greenbelt, Md.
CRUSTAL MAGNETIC FIELD VERIFICATION AND REPRESENTATION
R. A. Langel 301-344-6565
(677-45-03; 677-45-07; 677-43-08)

Low signal to noise ratios in satellite crustal magnetic anomaly data continue to require research into filtering and field source separaion techniques. At the same time, updated mathematical representations of the anomaly data are required for on going analysis and interpretation efforts. Objectives are to develop and apply techniques for isolating, mapping, and representing the true magnetic fields at satellie altitude due to crustal sources. Final selection by visual and statistical analysis of POGO and Magsat anomaly data will be completed and averaged anomaly maps derived and published. Investigation of the 'true' zero level will continue by application of new main field modeling techniques, modifications to the present along track filtering techniques, and development of two dimensional filtering. Equivalent source representations will be derived. The study of the applicability of Wiener filtering will continue. This RTOP supports the nonrenewable program which in turn supports the end objective of resource assessment. Other objectives include: final publication of POGO anomaly data; new methods for isolation and representation of anomaly fields; and global maps from combined POGO and Magsat anomaly data.

W82-70466 **677-45-07**
Goddard Space Flight Center, Greenbelt, Md.
RESOURCE IMPLICATIONS OF ARCTIC BASIN TECTONICS
P. T. Taylor 301-344-5554

The purpose is to determine the amount and nature of the geologic and structural information encoded in the magnetic data (both scalar and vector) recorded at satellite altitude by the Magsat and POGO spacecraft. The effort is primarily concerned with a study of the Arctic region. These satellite derived data should reveal broad, regional crustal anomalies and they should be correlated with the oceanic crustal transition. It will be necessary to determine which, if any, geologic parameters are dominant in controlling the magnetic anomaly signature. An effort will be made to match or represent the satellite geophysical data by models derived from the published bathymetric and topographic maps together with the magnetization values obtained from the geologic literature. Other geophysical information such as crustal thickness, heat flow, and gravity data will be used to construct the models. Other objectives are to determine the nature and origin of the major physiographic feature in the Arctic, especially the Amerasian Basin, based on satellite magnetic scalar and vector field. A preliminary economic assessment will be determined.

W82-70467 **677-47-03**
Jet Propulsion Laboratory, Pasadena, Calif.
JPL AIRBORNE RADAR RESEARCH PROGRAM
W. E. Brown 213-354-2110

The objective of this RTOP are to investigate, implement, and test techniques in the use of radar amplitude, phase, and frequency signatures of surface features as applied to Earth resources and ocean surface monitoring. These techniques will be verified with airborne radar and the results provided for the support of spaceborne radar mission planning and implementation.

W82-70468 **677-47-05**
National Space Technology Labs., Bay Saint Louis, Miss.
AIRCRAFT MULTIBAND IR SCANNER
G. F. Flanagan 601-688-3326

The purpose is to develop a multispectral aircraft scanner capable of obtaining measurements in the 8 to 13 micrometer wavelength region of the electromagnetic spectrum. Measurement objectives are to simultaneously acquire data in six spectral channels with a precision (NEDT) equal to or less than 0.5 Kelvin in all chanels and a 2.5 milliradian instantaneous field of view. Other objectives are to: monitor and close out existing contract with Daedalus Enterprises, Inc., for the construction of the scanner instrument; design and fabricate necessary fittings, power cables, transmission couplings, etc., to install and operate the scanner within the NSTL Lear aircraft environment; and to obtain and evaluate engineering flight data to verify the performance of the instrument relative to design specifications.

W82-70469 **677-48-01**
Jet Propulsion Laboratory, Pasadena, Calif.
ER SEASAT DIGITAL SAR PROCESSING
Ching F. Leang 213-354-3798
(677-36-02)

The objective of this RTOP is to process Seasat radar data to produce synthetic aperture radar images of land areas in North and Central America in support of earth resource application investigation studies. The processing will be performed using the upgraded Interim Digital Processor (IDP) in JPL. Each image will exhibit a 25 meter resolution and cover a 100 km square target area. At least 100 images will be produced in FY-82.

W82-70470 **677-48-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SPATIAL RADAR IMAGE REGISTRATION
M. Naraghi 213-354-6116
(677-41-04)

The overall objective of this task is to develop SAR image registration methods with increased accuracy and a higher level of automation. The newly developed procedure, which is based on a radar specific distortion model and incorporates digital topographic information in defining the geometric transportation, will be expanded to use all available and pertinent ephemeris data. The key effort in this regard will be fully automate this process so that the present preconditioning of the images will be done based on the information obtained from the radar system parameters and the few tiepoint locations. The procedure will also be fully evaluated by applying it to areas of varied topography while measuring the registration error and developing methods to minimize it. A particular procedure which is to be pursued is that of improving the radar parameter estimates by using the information furnished by the tiepoints. Currently preprocessing methods are being considered in order to facilitate the difficult task to tiepoint identification. One particular method currently under investigation is the development of a procedure to associate the saturated areas of the radar image to corresponding areas of the topographic data whose slopes are close to normal to the radar beam. In addition, texture, edge detection, and various filters will also be considered for final pixel to pixel association of the radar image and the topographic data.

W82-70471 **677-80-16**
Goddard Space Flight Center, Greenbelt, Md.
THE HEAT CAPACITY MAPPING MISSION ANTHOLOGY
N. Short 301-344-7870

The objectives are to prepare 'The HCMM Anthology,' a summary report of HCMM program results requested by NASA Headquarters to meet a need to highlight the types of data and applications that stem from determining apparent thermal inertia and temperature distributions within land surface materials as observed by satellite-borne sensors. The approach consists of: (1) selecting outstanding HCMM images from several sources; (2) analyzing and interpreting these images and describing them through maps with captions; (3) computer processing several HCMM data sets to produce special maps; (4) writing sections for the Anthology that treat principles of thermal remote sensing and application of HCMM data, and drawing upon investigator reports where pertinent; and (5) assembling these inputs into a final document for publication. The expected results will consist of a document of approximately 150 pages summarizing HCMM Project results with emphasis on visually interpreted images. This will be essentially a picture book designed to acquaint

the professional community with the nature of thermal images from space.

W82-70472 **677-80-20**
National Space Technology Labs., Bay Saint Louis, Miss.
AIRCRAFT DATA PROCESSING FACILITY UPGRADE
Ferron H. Resinger 601-688-3586
(677-27-14)

NSTL'S Earth Resources Laboratory (NSTL/ERL) developed a system for reading pulse code modulated (PCM) data from 1 inch wide instrumentation tape and converting it from PCM format to non-return-to zero (NRZ) format required by conventional computers in CY-1971. The system was upgraded slightly in 1974 and again in 1976, but some components in the system are getting quite old, and need to be upgraded to make the system more reliable and to add capabilities that will enable the system to support current and future planned requirements. The system's CY-1971 model tape reproducer will be replaced, the EMR bit synchronizers will be refurbished, a CRT display device will be provided, a quick-look film recording device will be added, a switching mechanism will be added to insure that the preprocessor will be supported by either of two modern computers to increase reliability, and a modest capability will be incorporated to perform quality checks on the TIMS and TMS data.

OFFICE OF SPACE SCIENCE

Planetary Geology

W82-70473 **151-01-20**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY GEOLOGY
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface process is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data as well as place boundary conditions on planetary evolution. The study of appropriate analogues not only places boundary conditions on the evolution of other planets such as Mars but also permits, on Earth, the evaluation of the characteristics of planetary surface instrumentation. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogues of Martian surface material. Specific objectives are: (1) to determine through detailed grain-by-grain studies of several terrestrial soils the processes and history that can be deduced through such data; (2) to devise techniques that optimize sample preparation, data collection, and data processing of soils to extract the maximum amount of information; (3) to characterize the gases released by thermal decomposition of Martial surface analog materials and evaluate the feasibility of accomplishing such analyses in situ, (4) to simulate the mechanical, chemical, and radiative weathering environments on Mars and Venus and study in detail the resulting products of a number of materials subjected to such conditions; and (5) to map the volcanic stratigraphy on the surface of Io.

W82-70474 **151-01-60**
Ames Research Center, Moffett Field, Calif.
PLANETOLOGY: AEOLIAN PROCESSES ON PLANETS
J. B. Pollack 415-965-5530

The objective of this research is to determine the parameters governing aeolian (wind) processes for appropriate planetary objects (Earth, Mars, Venus, possibly Titan), using wind tunnel simulations, laboratory experiments, earth analog studies, theoretical studies, and analyses of spacecraft data. The approach is to conduct experiments using wind tunnel and other laboratory apparatus under simulated earth conditions, check the results in the field on earth, then repeat the experiments in a simulated extraterrestrial environment, in order to learn about: (1) conditions for initiating and sustaining particle movement; (2) model studies of erosion and deposition associated with various land forms; (3) rates of wind erosion/abrasion; (4) the microtexture of materials subject to aeolian abrasion; and (5) characteristic signatures at orbital scales of aeolian landforms. Field experiments and analog studies provide a continuing check of the results from laboratory experiments and theoretical studies. Data from Mariner 9 and Viking provide information for Mars, Pioneer-Venus and Venera data are used for Venus, and newly acquired Voyager data for the Saturn encounter allow preliminary assessment of the aeolian regime on Titan.

W82-70475 **151-01-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY GEOLOGY
Ronald S. Saunders 213-354-3815

The proposal for Planetary Geology and Mars Data Analysis studies consist of ten tasks to be carried out in FY-82. These tasks are being performed in a variety of disciplines: (1) Mars fluvial features; (2) photogeology; (3) planetary geomorphology; (4) planetary image facility; (5) surface weathering; (6) surfaces physical processes; (7) variable features on Io; (8) planetary radar; and (10) asteroid population.

W82-70476 **151-02-60**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF PLANETARY BODIES
J. B. Pollack 415-965-5530

The purpose of this research is to obtain a better understanding of selected problems pertaining to planetary surface phenomena, the composition, structure and evolution of planetary bodies and their satellites, and the origin of the solar system by means of theoretical investigations employing the results of spacecraft and ground based experiments. Theoretical knowledge, physical insight, and mathematical modeling techniques are used together with astronomical and geological data to construct self-consistent mathematical descriptions of planetary processes and structures. Analysis and interpretation of the results of these model calculations are applied to such topics as the evolution of Jupiter and wind blown surface features and climatic changes on Mars.

Planetary Materials

W82-70477 **152-01-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: ANALYSIS OF EXTRATERRESTRIAL SAMPLES
J. Dietrich 713-483-3274

Analysis of extraterrestrial samples is a multidisciplinary effort carried out by individual scientists and teams consisting of three program areas: (1) lunar samples; (2) meteorites; and (3) cosmic dust. The Analysis of Extraterrestrial Samples Program is a continuing effort aimed at understanding the origin and history of the Moon, Earth, and Solar System, including their age, chemical and mineral compositions, and physical properties. Data obtained provide valuable information on the history of the Sun and baseline data for the planetary processes that will aid in the planning for future planetary missions.

W82-70478 **152-02-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: LABORATORY AND ANALYTICAL STUDIES
R. J. Williams 713-483-2781
(152-04-40; 153-06-40)

The objective of this research is to produce a quantitative understanding of the chemical and physical properties of planetary materials and of the processes by which these materials have been formed and evolved. This quantitative understanding is obtained through analytical studies of lunar samples, meteorites, cosmic dust, and closely related synthetic or terrestrial materials. A variety of analytical techniques (X-ray fluorescence, instrumental neutron activation, solid source and gas mass spectrometry, gas chromatography, ion and electron microprobe analysis, and scanning and transmission electron microscopy) are used, as

appropriate, to quantitatively determine the physical, chemical, and mineralogical properties of planetary materials.

W82-70479 **152-03-60**
Ames Research Center, Moffett Field, Calif.
STUDIES OF THE DISTRIBUTION OF ELEMENTS AND MINERAL PHASES AMONG METEORITES
H. P. Klein 415-965-5094

The purpose of this research is to gain an understanding of the origin and evolution of meteorites through the study of their chemistry and mineralogy and to gain insight into the conditions and processes that prevailed at the time of the solar system's origin. The abundance, isotopic composition, and distribution of selected elements and the occurrence and distribution of various minerals in meteorites will be examined. Systematic searches for elemental, isotopic, and mineralogic petrologic correlations between meteorites and within a meteorite will be made so as to elucidate physical chemical relationships in the meteorite population. These relationships will be used to test the hypothesis that meteorites originated as condensates from the cooling solar nebula.

W82-70480 **152-04-40**
Lyndon B. Johnson Space Center, Houston, Tex.
CURATION OF EXTRATERRESTRIAL SAMPLES
M. B. Duke 713-483-4464

This program provides for the maintenance of the lunar sample collection under secure, controlled environment conditions; for the description of samples as new materials are prepared for analysis; for the maintenance of records of the status and distribution of lunar samples; for providing lunar samples to approved investigators and for display purposes; and for technical monitoring of domestic lunar sample investigators. It also provides similar functions for cosmic dust samples and the Antarctic meteorite collection, including initial description, processing for distribution to investigators, maintenance under controlled environment, and dissemination of information on meteorite collection. It provides for development of curatorial techniques for, and educational use of, materials from the various collections. Operation is directed by Civil Servant scientists and administrators, and undertaken by support contractor personnel. The program provides samples and information for 81 domestic and foreign lunar sample investigator groups and over 100 meteorite investigator groups. The cosmic dust program was initiated in FY-81 and expects to provide materials for six to ten laboratories during FY-82.

W82-70481 **152-05-40**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC GENERAL OPERATIONS SUPPORT - PLANETARY MATERIALS
M. B. Duke 713-483-4464

This plan provides for support by the Johnson Space Center (JSC) of a general operational nature necessary to the planning and conduct of Office of Space Science Planetary Materials Programs. The plan provides JSC support services for the annual lunar and planetary science conference and the visiting scientist programs of the NASA. Support services include logistics, publications, library, audio-visual, photographic, data processing, fabrication, and in-house laboratory utilization. A certain amount of in-house laboratory operations are dedicated through this plan to general program support such as that provided to pre-proposed definition studies, specialized studies for the sample curator, and mission support activities. This plan also supports a continuing study by in-house scientists to define the role of the planetary program. This study systematically identifies gaps in current knowledge and defines specific scientific requirements for future space missions.

Planetary Geochemistry and Geophysics

W82-70482 **153-01-60**
Ames Research Center, Moffett Field, Calif.
FORMATION, EVOLUTION, AND STABILITY OF PROTO-STELLAR DISKS
P. M. Cassen 415-965-5597

The objectives of this research are: (1) to obtain an understanding of the solar nebula and proto-stellar disks in general by analysis of theoretical models based on hydrodynamic and thermodynamic principles (the optical and infrared appearance of proto-stellar accretion disks and circumstellar dust disks will be studied and the results applied to observations of solar type and other stars in young clusters); (2) to examine, by numerial experiments, the stability of proto-stellar disks against gravitational condensation, and to explore the role of instabilities in planetary formation. Results will be analyzed in the light of observations of the solar system and astronomical objects identified as proto-stars.

W82-70483 **153-02-40**
Lyndon B. Johnson Space Center, Houston, Tex.
EXPERIMENTAL STUDIES
W. C. Phinney 713-483-3816

The objective of this research is to develop the values of necessary parameters that allow a quantitative understanding of the chemical and physical processes that produce observed planetary materials. The development of the necessary data is accomplished by means of experimentation with both natural and synthetic materials under controlled conditions of temperature, pressure, oxidation reduction, and composition. Specific mineralogic compositions, textural relations, and phase assemblages can thus be related to specific sets of chemical and physical conditions that may occur on or within planetary bodies. These conditions provide constraints for interpretations of planetary processes.

W82-70484 **153-02-70**
Jet Propulsion Laboratory, Pasadena, Calif.
JPL PETROLOGY SUPPORT
Anthony A. Finnerty 213-354-4785

The objective of this task is to constrain theories of planetary formation and evolution by application of experimental petrology, phase equilibrium, and thermodynamic theory, and to relate observable surface features to models for planetary interiors. This task is approached in three ways. New experiments at pressures and temperatures representative of igneous and morphic rock forming processes are conducted in two piston cylinder devices at the Jet Propulsion Laboratory, and in other facilities at other laboratories. Experimental and theoretical data on phase equilibrium and thermodynamics are incorporated into models of petrologic and thermal state of planetary interiors. Geothermometers and geobarometers are applied to terrestrial rocks, both to test their performance and to study petrologic and thermal state of the upper mantle of an accessible planet, Earth. The tested thermobarometers are then applied to selected examples of extraterrestrial rocks. Certain surface features of planetary bodies, studied from spacecraft photography, are analyzed in terms of interior processes.

W82-70485 **153-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY INTERIORS
Erik R. Ivins 213-354-2046

This RTOP contains two tasks: one pertaining to thermal modelling of comets, the other dealing with the structure and evolution of the terrestrial planets and Galilean satellites. The goal of these modeling efforts is to attempt to provide better constraints on interior properties, composition etc., and also to identify the key parameters which control the evolution, structure, and physical processes of these planetary bodies. Computer models will be used to simulate cometary thermal and chemical processes utilizing non model dependent observational constraints as comparisons. Emphasis will be placed upon a more detailed coma model. Computer models will also be

used to simulate deep interior thermal and chemical transport processes with emphasis upon comparative planetological studies. Emphasis will also be placed upon codes which may simulate the gravity and topographic fields in both spherical and cartesian coordinates.

W82-70486 **153-05-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY DYNAMICS
William R. Ward 213-354-2594

This program of dynamical investigations is directed at increasing and understanding of solar system formation and evolution. The tasks contained herein can be grouped into three broad categories: solar system formation asteroids and comets; and planetary orbital and rotational studies. Important constraints on theories of solar system formation may be provided by a study of scanning secular resonance theory and of nebula planet tides or density waves. Work on accretion and on ring dynamics will continue. Detailed mapping of the morphology of major secular resonance surfaces in (a,e,I) phase space for the asteroid belt will provide a better evaluation of such resonances as a mechanism for delivery of meteoritic material to the Earth and Mars. Observations of asteroid rotations from Table Mt. Observatory and accurate measurements of the positions of selected comets and minor planets from Palomar Schmidt photographic collections and the Cunningham plates will continue. A study of comet perihelia distribution for new long period comets will commence. Advanced modeling of the dynamics of the Oort Cometary cloud will proceed. Planetary orbital and rotational studies will include: investigation of the Enceladus-Dione resonance, a development of wobble resonance theory, an improved theory for secular variations of the solar system, a study of Tricon's orbit, consideration of the dynamic behavior of the Pluto-Charon pair, and a paper on the origin and dynamical effects of a lunar liquid core.

W82-70487 **153-06-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY SYNTHESIS
Gary A. Ransford 213-354-2451

This RTOP consists of five tasks in the areas of comparative planetology of satellites, geochemical mapping with gamma ray data, multispectral data analysis for the Moon and planets, planetary gravity analysis, and analysis of the geochemical/surface characteristics of the Jovian satellites.

W82-70488 **153-07-50**
Goddard Space Flight Center, Greenbelt, Md.
CROSS SECTION DETERMINATION, COSMIC RAY INDUCED BACKGROUND DETERMINATION AND NEUTRON TRANSPORT CALCULATIONS
J. I. Trombka 301-344-5941

The objective of this investigation is to obtain cross sections and develop neutron and gamma-ray transport methods for predicting the magnitude and spectral distribution of cosmic-ray and neutron induced gamma-ray emission from cometary, planetary, and asteroid bodies. Similar calculations are required to predict the background produced in detector materials by cosmic-ray primaries and secondaries. A major problem in the interpretation of gamma-ray spectroscopic data with respect to chemical analysis of planetary bodies is the lack of information on cross sections and discrete line gamma-ray emissions from certain key elements (e.g., C, O, and H). Both theoretical and experimental studies will be used to obtain this information. Furthermore with improved cross sections and spectral data, neutron and gamma-ray transport calculations will be carried out to better understand the expected gamma-ray emission from planetary asteroids and cometary surfaces as a function of hydrogen and macroscopic cross sections. Correction factors for changes in the fast to thermal ratio and flux depressions will be derived. These results will be used to correct the Apollo gamma-ray data since such corrections were not included in the original analysis. This work would be performed in cooperation with groups at UCSD, JPL, and LASL.

W82-70489 **153-07-70**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING
Douglas B. Nash 213-354-4154

This RTOP supports four studies aimed at deciphering the surface properties of planetary bodies by remote sensing techniques. The techniques to be utilized include spectral reflectance and spectrogeometry in the UV-visible-IR bands, infrared thermal emission in the mid-IR, and imaging radar. The studies involve coordinated laboratory and theoretical work as well as telescopic observations. These studies have direct application to the interpretation of observational data obtained by spacecraft such as Voyager, Galileo, and VOIR. These studies will allow better estimates to be made of the composition, structure, and processes of surfaces of various planetary objects such as Galilean and Saturnian satellites. The approach to be taken differs with each study as follows: (1) Planetary Radar - working groups will be set up consisting of representatives of various institutions involved in imaging radar development in order to discuss and define future research and development needs for conducting successful radar imaging of planetary surfaces; (2) Surface Properties of Planetary Satellites - laboratory and theoretical studies of the spectral reflectance and other physical properties of various candidate materials such as SO2, sulfides, and other sulfur bearing compounds that are thought to compose the surface of Jupiter's satellite Io; (3) Io Heat Flow - ground based infrared data will be obtained by large telecopes observing Io when it enters and emerges from Jupiter's shadow in order to determine the spatial distribution and intensity of internal heat flow at Io's surface and to derive heat production mechanisms and other geodynamical implications of Io's interior; and (4) Planetary Spectrogoniometry - laboratory studies of the dependence of visible and IR reflectance spectral bands on the viewing geometry of a planetary surface will be conducted in order to develop a basis for interpretation of optical reflectance data acquired by spacecraft such as Galileo.

W82-70490 **153-08-40**
Lyndon B. Johnson Space Center, Houston, Tex.
IMPACT PHENOMENA
W. C. Phinney 713-483-3816

The objective of this research is to develop the values of necessary parameters that allow a quantitative understanding of the chemical and physical processes that produce observed planetary materials. The development of the necessary data is accomplished by theoretical calculations, observations of the meteoroid flux, and experimentation with both natural and synthetic materials under controlled conditions of temperature, pressure, oxidation reduction, shock, and composition. Specific theories, fluxes, mineralogic composition, textural relations, and phase assemblages can thus be related to specific sets of chemical and physical conditions that may occur on, within, or between planetary bodies. These conditions provide constraints for interpretations of planetary processes.

W82-70491 **153-08-50**
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTAL MAGNETISM
P. J. Wasilewski 301-344-8317

The objectives include: (1) to conduct an experimental magnetism program which will provide (a) new information about shock induced magnetization and remagnetization in iron and iron-nickel alloys and (b) new information about magnetic properties of iron-nickel alloys; (2) to develop metallographic magnetic criteria in order to provide a basis for analysis of the magnetic record in extraterrestrial materials; and (3) to utilize this new information in evaluating both laboratory developed magnetic records in natural and synthetic samples and the natural magnetic record in specific natural samples. The light gas gun located at the Goddard Space Flight Center will be utilized to impact discs of Copper-(0.5 to 1.0 wt % iron) alloys which are heat treated to precipitate antiferromagnetic face centered cubic (fcc) iron spheres ranging in size from 100 A to 2000 A. The impact transforms the fcc iron spheres to the ferromagnetic body centered cubic (bcc) state in controlled external fields. Magnetic characterization before and after impact provides a monitor of

shock induced shape change, the effect of shock induced substructure, etc. Much of the effort during FY-82-83 will be devoted to completion of the shock experiments, measurements of sample magnetic properties, and reporting of results. The magnetic effects associated with first order shock induced magnetic transition and changes due to annealing shock induced substructure and microstructure will be evaluated.

W82-70492 **153-08-60**
Ames Research Center, Moffett Field, Calif.
NASA AMES RESEARCH CENTER VERTICAL GUN FACILITY
C. E. DeRose 415-965-6178

The Ames Research Center Vertical Gun Range is a ballistic facility used to simulate and study the physics and mechanics of planetary impact cratering phenomenon. Ballistic technologies utilizing light gas and gun powder enable acceleration of projectiles up to 2 centimeters in diameter at relative velocities of approximately 8 km/sec. By varying the gun's angle of elevation with respect to the target vacuum tank, impact angles from 0 deg to 90 deg with respect to the gravitational vector are possible. In conjunction with the Lunar and Planetary Institute, Ames Research Center (ARC) operates the Ames Vertical Gun Facility as a national facility. The ARC's responsibility is to manage the Vertical Gun Facility operations, including manpower, expendables, targets, etc.; maintain equipment; and provide for facility modification and upgrading, as needed. The ARC operates the facility in such a manner as to provide maximum support to the scientific community in the study of impact processes in planetary formation and modification.

W82-70493 **153-09-40**
Lyndon B. Johnson Space Center, Houston, Tex.
EARLY CRUSTAL GENESIS
W. C. Phinney 713-483-3816

Physical and chemical constraints must be developed for the processes involved in the origin and evolution of the solid objects of the solar system. Such constraints are necessary if meaningful models are to be developed for the evolution of specific objects. Petrologic chemical, isotopic and tectonic studies, and models of the evolution of planetary crusts are underway with a strong basis in lunar and terrestrial data. Major efforts will be devoted to studying lunar samples that are related to the early lunar crust, searching for early terrestrial crustal units, studying materials from potential terrestrial analogs of early planetary crusts and modeling crustal evolution.

W82-70494 **153-10-40**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC GENERAL OPERATIONS - GEOPHYSICS AND GEOCHEMISTRY
M. B. Duke 713-483-4464

A variety of institutional and scientific support tasks at JSC that are considered essential for the conduct of research and for implementation of the Planetary Geophysics and Geochemistry Program are provided. Center support services such as printing, computer, photographic, and graphics are provided to the Lunar and Planetary Institute through a procedural agreement. In house support provides for cosponsorship of conferences, laboratory costs required by visiting scientists using existing facilities, and for costs required to operate common laboratory facilities and to provide for support services from other Center elements.

W82-70495 **153-10-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PROGRAM OPERATIONS
Douglas B. Nash 213-354-4154
(153-07-07)

This RTOP supports the specific objectives of conducting laboratory experiments on the surface and exospheric properties of planetary satellites of the outer planets. Specifically, it will provide upgrading of equipment needed to refine the capability at JPL of conducting relevant experiments for proper interpretation of observational data being obtained by spacecraft missions and ground based studies of Jovian and Saturnian satellites. It involves the purchase, modification, and integration of complex vacuum chambers, pumps, various ancillary equipment, UV-visible-IR spectrometer and light chambers, pumps, various ancillary equipment, UV visible IR spectrometer and light source systems, proton and heavy ion low energy particle irradiation systems, fabrication of vacuum chambers and associated gas handling systems, and interface equipment for computer processing and plotting of reflectance and emission spectra. This RTOP also supports a JPL detailee to the Planetary Geophysics and Geochemistry Program office, NASA Headquarters, in FY 82.

Planetary Atmospheres

W82-70496 **154-10-80**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY ATMOSPHERES COMPOSITION AND STRUCTURE
Glenn S. Orton 213-354-2183
(154-40-80; 889-56-47)

The overall objective of this RTOP is the development of a comprehensive scientific basis for understanding the structure of planetary atmospheres and the underlying atmospheric physical processes. The research to be carried out includes the development and application of techniques for remote temperature/opacity profile recovery, limb-darkening analysis, radiative transfer and energy transport modeling, imaging and mapping, and molecular line by line transmission calculations. Using available information acquired from laboratory investigations and both ground based and spacecraft infrared observations, it is proposed to determine the mean values and variations in time and location of (1) temperature structure, (2) bulk chemical composition and the abundance of minor and trace chemical constituents, (3) properties of clouds and hazes, and (4) planetary internal heat sources. Using all existing constraints from direct observations it is proposed to derive the atmospheric temperature structure using accurate models for the deposition of solar energy, the deposition of planetary (infrared) energy, the relative contributions of radiative and convective energy transport mechanisms, and the potential contributions of other sources and sinks of energy. The equilibrium models for energy transport will be based on a straightforward flux divergence formulation, using direct energy conservation expressions.

W82-70497 **154-10-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERIC COMPOSITION AND STRUCTURE
J. B. Pollack 415-965-5530

Theoretical modeling and spacecraft data interpretation are used to determine the properties and physical processes characteristic of planetary atmospheres. These properties include their temperature structure, aerosols, cloud layers, gaseous constituents, and opacity sources. Emphasis is placed on reducing and analyzing data returned from spacecraft missions, such as Pioneer Venus and Voyager or preparing for data expected from future spacecraft missions, such as Galileo and SOP(2). However, use is also made of relevant ground based observations. Tasks relevant to Pioneer Venus include data analysis of results from the large probe infrared radiometer, atmospheric structure, and gas chromatography experiments. Other tasks are directed at investigating the properties of Titan's atmosphere and the coma of comets. Such investigations are relevant for both the Voyager mission through the Saturn system and the contemplated SOP(2) mission.

W82-70498 **154-20-80**
Jet Propulsion Laboratory, Pasadena, Calif.
DYNAMICS
Richard W. Zurek 213-354-3725

The basic interaction between dynamics and radiatively active airborne dust prominent in the dusty Martian atmosphere will be simulated in the study of the planetary scale evolution of Martian great dust storms. The dynamical meteorology of the stratosphere of Venus will be examined with emphasis on the

zonally averaged and solar related flows, and instability mechanisms. A representative subset of the Voyager Jupiter photographs will be assembled into time lapse motion pictures which will clearly and accurately portray the visible activity of features in the Jovian atmosphere over two periods of several weeks each. These 16 mm motion pictures, showing constant regions of the planet on successive rotations, and digital records of the map projected data sets will be delivered to the National Space Science Data Center (NSSDC) in forms which can readily and economically be accessed by any investigator engaged in meteorological research. Pioneer Venus and ground based data are to be used to characterize the dynamics of the polar hot spot dipole and cold polar collar, to derive necessary physical parameters for existing models of the zonal circulation, and to examine the magnitude and character of the solar related component of atmospheric circulation and temperature structure of Venus.

W82-70499 **154-20-80**
Ames Research Center, Moffett Field, Calif.
DYNAMICS OF PLANETARY ATMOSPHERES
R. E. Young 415-965-5515

The dynamics of the atmosphere of Venus is being studied using a three dimensional circulation model. The fully coupled nonlinear momentum and energy equations are solved numerically using a combination of finite difference and spectral methods. The principal goals are to compare model results with Pioneer Venus data and attempt to understand the dynamical effects of varying planetary rotation rate, solar energy deposition, infrared opacity, atmospheric mass and composition.

W82-70500 **154-20-80**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMICS OF PLANETARY ATMOSPHERES
J. A. Pirraglia 301-344-6783
(889-56-47)

The objective of this RTOP is to apply geophysical fluid dynamics to planetary atmospheres in general and to study similar dynamical phenomena under different conditions. The planets and their satellites present contrasts in mass, rotation rate, radiative time constants, heat deposition, and topographic influence on their atmospheres. These disparate atmospheres present an opportunity to apply theoretical models to a wide range of parameter space using the data obtained from planetary missions. Atmospheric circulation is strongly affected by energy and momentum transport. The relationship between the mean flow and waves that contribute to the transport processes will be investigated. This will be accomplished by the development of a general spectral solution of the equations which describe the wave mean flow dynamics. The generalized solution will be used to study the role of instabilities and forced waves in the transport of energy and momentum under the variable boundary conditions encountered on the planets.

W82-70501 **154-30-80**
Jet Propulsion Laboratory, Pasadena, Calif.
CLOUDS, PARTICULATES AND ICES
Martha S. Hanner 213-354-4100

This RTOP covers five activities: (1) infrared emission of cometary dust; (2) Venus cloud properties; (3) Jovian cloud properties; (4) structure of Venus' middle atmosphere; and (5) SO2 processes in the Io atmosphere. The objective of the Venus cloud study is to understand the condensation properties of the clouds, their liquid content, growth of cloud droplets, possibility of precipitation, and Venusian lightning. Mariner 10 and Pioneer Venus radio occultation data and probe data are used to derive the liquid content of the clouds. Effects of lightning on the chemical properties of sulfuric acid water clouds will be studied experimentally. The objective of the cometary dust study is to compute the thermal emission of cometary dust grains as a function of particle size, wavelength and heliocentric distance for ice, silicates, and absorbing materials. These models are compared with observations in order to derive the composition and dominant size range of the dust being emitted from specific comets, and are applied to predicting dust emission characteristics for potential target comets of a cometary mission. The objective of the Jupiter cloud study is to use Voyager Imaging and IRIS data, combined with high resolution ground based 5 micrometer images, to determine physical parameters for the Jovian and Saturnian clouds, including morphology, vertical wind shear in the Equatorial Zone, and upper atmosphere temperature structure. The objective of the Venus middle atmosphere study is to use P/Venus OIR data to characterize high altitude hazes, study the vertical and horizontal extent of terminator locked thermal features and the role of aerosols in their formation, and determine latitudinal and temporal variability of total solar energy deposition. The objective of the Io study is to use IUE and ground based data to determine the basel pressure of SO2 in the IO atmosphere, which forms a critical test of the regolith cold trapping model; determine the contribution that SO2 gas makes to Io's ultraviolet reflection spectrum and estimate the rate at which Io's atmospheric SO2 supplies particles to the Jovian magnetosphere.

W82-70502 **154-30-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY CLOUDS, PARTICULATES AND ICES
R. C. Whitten 415-965-5498
(154-75-80; 147-30-02; 154-10-80; 146-10-04)

A simple microphysical model of the Titan aerosol has been developed. The model will be modified to include a source of aerosol forming material generated by an appropriate atmospheric chemistry model developed under RTOP 154-75-80. The results will be used to set limits on atmospheric parameters such as eddy diffusivity. Models of condensational clouds on Titan and the outer planets will be developed and their prediction compared to observational data. A microphysical model of the Venus clouds has been developed. The model will continue to be used to interpret data obtained by Pioneer Venus probe instruments. It will also be used to search for important but still unrecognized processes associated with the clouds and for possible errors in interpretation of cloud structures. A series of models is being used to evaluate interactions between dynamics, radiation, electric fields, and clouds. The cloud model will be used to look for processes which might cause precipitation and electric charging. A radiative model is used to clarify the relative importance of cloud and gas opacity to the unstable region at the cloud base, and a simple dynamic model is used to assess the magnitude of the cloud radiation dynamics interactions.

W82-70503 **154-40-80**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIATIVE TRANSFER
Glenn S. Orton 213-354-2183
(154-10-80; 889-56-47)

The objective of this RTOP is the development of accurate numerical approaches for the interpretation of infrared remote sensing data obtained under realistic conditions, in the presence of anticipated measurement noise as well as in the presence of clouds and aerosol. Two important problems will be addressed: (1) determination of atmospheric temperature profiles in the presence of clouds and aerosols when cloud cover is uniform or when temperature and cloud variations are highly correlated; and (2) determination of both macro and microphysical cloud properties. The approach will use a relaxation technique developed by Chahine, coupled with accurate and efficient radiative transfer algorithms, together with a simultaneous theoretical approach to these problems. Testing of these techniques will be done using numerical simulations of data, comparing the conditions of the generating model with those retrieved by the technique.

W82-70504 **154-50-80**
Jet Propulsion Laboratory, Pasadena, Calif.
ATOMIC AND MOLECULAR PROPERTIES
Murray Geller 213-792-2593

A broad program of theoretical and experimental studies pertaining to planetary atmospheres will be conducted. The properties and the parameters of the constituents of planetary and cometary atmospheres will be studied. Experimental data (laboratory, astronomical and spacecraft) will be applied to the understanding and interpretation of spectral features of complex planetary and cometary atmospheres. The findings will be applied toward the design of ground based and spacecraft experimental concepts. The studies to be conducted in FY 82 pertain to the

determination of millimeter and submillimeter spectra, theoretical spectroscopic development and continuation of collaborative effort with Dr. G. Birnbaum of the National Bureau of Standards on long path, multithermal measurements of the opacity of the major constituents of planetary and cometary atmospheres in the far infrared.

W82-70505 **154-50-80**
Goddard Space Flight Center, Greenbelt, Md.
ATOMIC & MOLECULAR PROPERTIES OF PLANETARY ATMOSPHERIC CONSTITUENTS
J. J. Hillman 301-344-7974
(196-41-54; 147-10-01; 188-41-55)

The principal goal of this laboratory spectroscopy program is to develop an organized body of knowledge of the molecular properties of planetary atmospheric constituents. The highest possible spectral resolution is required when single features apparent in medium or high resolution Fourier transform (FTS) spectra are composed of more than one molecular transition, and the parameters frequency, strength, lower state energy, and foreign broadening must be known for each as input in modeling the atmosphere. For infrared heterodyne observations the need for ultra high resolution laboratory data is especially critical, since the bandwidths accessible to these receivers are narrow and Doppler line profiles are completely resolved in the observed spectra. In the case of lower resolution planetary observations, such as Voyager IRIS (4/cm), identifications and abundance determinations require laboratory spectra of similar resolution which can be directly compared with the observations. A combination of tuneable diode laser (TDL) and FTS laboratory spectra can supply a complete set of line parameters anywhere in the infrared. In this program TDL and FTS spectrometers will be applied to selected vibration rotation bands of planetary molecular species.

W82-70506 **154-60-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: THEORY AND ANALYSIS
Wesley T. Huntress 213-354-2140
(154-75-80)

This RTOP is a small task to continue work in developing a model of the chemistry in cometary comae. The objective is to identify the major photochemical and ionic processes occurring in cometary comae by comparing observations of the column densities of key constituents observed in comet spectra with column densities predicted by models with differing initial parent composition. The work is closely allied to laboratory work being conducted on ion molecule reactions in comets, and will be applied to ground based observations and ultimately to observations of Halley by spacecraft.

W82-70507 **154-60-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY AERONOMY: THEORY AND ANALYSIS
R. E. Hartle 301-344-8234

The objective of this RTOP is to study the observed properties of the neutral atmospheres and ionospheres of the planets and their satellites, including Earth, in order to identify and interpret the physical and chemical processes governing their behavior, encompassing solar planetary relationships. The motivating philosophy here is that the study of processes occurring in the atmospheres and ionospheres of the planets and their satellites provides important insights into the nature of similar processes operative in the Earth's atmosphere and ionosphere under different parametric conditions and vice versa. These investigations are pursued by analyzing and interpreting experimental data derived largely from flight programs. The data are used to determine the various chemical, compositional, dynamical, and energetic states of the respective atmospheres and ionospheres, including the transport and deposition of mass, momentum, and energy in these regimes. In general, the approach involves the development of empirical descriptions of either global or small scale phenomena using data sets from a variety of spacecraft. These empirical descriptions of the atmospheres and ionospheres are subsequently interpreted using theoretical models developed to deduce the physical and chemical processes involved. Some of the specific phenomena addressed in this investigation include: atmospheric and ionospheric motions on Venus, Jupiter, and Earth, interactions of solar wind and/or magnetosphere with atmospheres of Venus, Titan, and Earth, including modification of transport coefficients by plasma instabilities, solar planetary relationships, comparative planetary atmospheres, etc.

W82-70508 **154-70-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: ENERGY DEPOSITION
Sandor Trajmar 213-354-2145

Electron impact excitation, ionization, and dissociation of atoms and molcules which are important in planetary environments (with major emphasis on the Jupiter environment) will be studied and cross sections for these processes will be determined. With a newly designed apparatus total scattering cross section for H2, SO2, and CH4 will be measured. High energy electron will be utilized as pseudo protons to generate photoabsorption and ionization data. The laboratory work will be coordinated with modeling efforts. Electron impact cross sections will be measured for EUV emission lines observed in the Jupiter Io torus originating from the ions OII and SII. Comparisons will be made to the Gaunt factor approximation. Extension to the N2(+) violet Band and CO(+) Comet Tail Band excitations for cometary modeling are planned. An experimental apparatus has been fabricated which can measure the optical emission cross sections and fluorescence spectra arising from electron impact. The objective is to perform systematic and comprehensive studies in the UV region of the spectrum (50-500 nm) of atoms (S, C, O, N, Na, Ar, K) and molecules (SO2, CH4, H2O, CO2, CO, NH3, CS2, N2) of planetary and cometary interest. The proposed laboratory measurements have immediate application to the modeling of Voyager and International Ultraviolet Explorer UV observations of the Jovian planetary system emissions and to the mission planning of Galileo UV observations.

W82-70509 **154-70-80**
Goddard Space Flight Center, Greenbelt, Md.
ULTRAVIOLET SPECTROSCOPY OF PLANETARY ATOMS AND MOLECULES
L. J. Steif 301-344-7529

The objectives of this RTOP research are to measure the optical properties of atoms, free radicals, and molecules which are important in understanding the composition of planetary atmospheres and comets. Emphasis is placed on those problems which are of immediate concern for interpreting the results of rocket, satellite, and planetary probe observations. Several types of spectroscopic measurements are made. First, photoabsorption and photoionization cross sections are measured. Cross sections are also determined for producing ion or atomic fragments in given excited electronic states. Branching ratios are measured for excited states which radiate into lower level excited states via photo emission. Electron impact excitation cross sections are determined.

W82-70510 **154-75-80**
Goddard Space Flight Center, Greenbelt, Md.
COSMIC CHEMISTRY: AERONOMY, COMETS, GRAINS
B. Donn 301-344-5014

This RTOP studies physiochemical phenomena in planetary atmospheres, comets, and related aspects of interstellar matter. Laser spectroscopy, photochemistry, reaction kinetics, and condensation processes are investigated and properties of atoms, radicals, molecules and grains are to be measured. These experimental results are to be used to interpret astronomical observations and develop theoretical models. Flash photolysis resonance fluorescence apparatus with computer interface for real time data analysis provides absolute atom molecule rate constants. A CW tunable dye laser is to be used for radical detection. An excimer laser alone or combined with a flashlamp is to be used for sequential photodissociation studies of planetary or cometary radicals. A tunable dye laser is to be used to detect and study the properties of these radicals. Gas phase and matrix isolation condensation is to be used to simulate primordial solar system, cometary or interstellar grains, and to study mechanisms of production. Particle accelerator irradiates ice

mixtures to study cosmic ray effects on comets. Vaporization process of simulated cometary ice mixtures is to be investigated with various gas composition analyzers. Spectra of comets, to mag 15 and beyond are obtained at Mt. Lemon Observatory, University of Arizona. The IUE observatory is to be used to obtain ultraviolet spectra of comets brighter than about mag 7.

W82-70511 **154-75-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: CHEMISTRY
W. T. Huntress 213-354-2140
(154-60-80)

The objective of this work is to conduct laboratory investigations of the ion chemistry in planetary atmospheres and cometary comae. The goal of the ion chemistry work is to obtain product distributions and rate constants for ion-molecule reactions important in the atmospheres of the planets, their satellites, and in cometary comae. The major emphasis in this fiscal year will be on Titan. The goal of this work is to elucidate the chemistry of the Venus atmosphere in the 60-90 km region. The roles of SO2 and HC1 in the Venus atmosphere will be studied, with the particular objectives of explaining the photochemical stability of CO2 and the detailed sulfur chemistry leading to cloud formation. A further goal of this is to provide programmatic support to NASA Headquarters in the area of laboratory studies, and to provide detailees and support in various program areas to NASA Headquarters.

W82-70512 **154-75-80**
Ames Research Center, Moffett Field, Calif.
AERONOMY OF PLANETARY ATMOSPHERES: CHEMISTRY
R. C. Whitten 415-965-5498
(154-30-80)

Theoretical modeling is used to determine the chemical properties of the atmospheres of Titan and the outer planets. In addition to methane, the presence of abundant quantities of nitrogen, established by Voyager I, is expected to lead to the formation of complex C-N-H compounds as a result of reactions induced by galactic cosmic rays (GCR), trapped particles in Saturn's magnetosphere, and solar radiation. The formation of these species, their growth into large polymers, and the formation of particulate material from the polymers will be investigated in order to assess their possible contributions to the Titan aerosol observed by Voyager. The outer planets have been observed to contain significant quantities of methane and ammonia, whose derivatives, formed by GCR, trapped particles and solar radiation, may react to produce complex hydrocarbons. The possible growth of these compounds into large polymers will be investigated. Results of research carried out under this RTOP will be used in research sponsored under RTOP 154-30-80 (Planetary Clouds).

W82-70513 **154-80-80**
Jet Propulsion Laboratory, Pasadena, Calif.
EXTENDED ATMOSPHERES
R. S. Wolff 213-354-5073

The first objective is the education of the general public about interplanetary research. The public is not well informed about scientific interest in the planetary medium and there are no good, nontechnical references on the subject. The work performed under this task will culminate in publication of a popular level (no equations) book which describes: (1) the contents of and processes which occur in interplanetary space; (2) the interaction of the interplanetary medium with the planets, comets, and spacecraft; and (3) the relevance of research in interplantary physics. The second objective is the study of comets. Methods based on a dynamical approach and photometric techniques are developed and applied to a variety of dust phenomena in comets to study the nature and surface morphology of the cometary nucleus and to determine the properties of cometary material. The primary objective for FY-82 is to investigate large scale nucleus surface topography of Comet Halley. Other objectives include the outgassing asymmetry of short period comets, which is used to determine their rotation and thermophysical parameters and to establish the relative effects of surface heterogeneity and insolation variations on the cometary activity; and the striated patterns in the dust tail of Comet 1957 V, which are evidence of particle fragmentation. The third objective is to study the interaction of Europa, Ganymede, and Callisto with the Jovian magnetosphere. The work performed under this task will include: (1) Determining the mass loading of the Jovian magnetosphere from these satellites due to photosputtering, energetic ion sputtering, and sublimation; (2) Studying the role of primitive (highly volatile) icy surfaces on these satellites in producing cometary-like interactions with the Jovian magnetosphere.

W82-70514 **154-80-80**
Goddard Space Flight Center, Greenbelt, Md.
EXTENDED ATMOSPHERES
H. A. Taylor, Jr. 301-344-6610

The objective of the RTOP is to advance the understanding of solar planetary relationships using the evidence of the global characteristics of ionosphere neutral atmosphere variations as indicators of coupling processes regulating the upper atmosphere in the region extending from the exobase to the ionopause. By examining the behavior of the ionic constituents at lower altitudes near the exobase and at higher altitudes approaching the ionopause, insight is obtained with respect to collision dominated as well as collisionless processes. Such studies relate to longer term effects such as the basic planetary atmosphere evolution as well as short term effects such as the ionospheric response to solar wind variability. The approach involves the examination and description of global data sets of satellite and ground based data relevant to the composition, structure, and energetic states of the planetary atmosphere ionosphere system. These descriptions include large scale results in the form of empirical models as well as phenomenological data sets descriptive of uniquely varying conditions or events. Results of the empirical studies are assessed in terms of current theoretical models. Comparison of model results for contrasting planetary conditions, e.g., Earth and Venus, provides a basis for testing basic physical concepts.

W82-70515 **154-90-80**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED EXPERIMENT DEVELOPMENT
Daniel J. McCleese 213-354-2317

The objective of this task is the development of advanced infrared instrumentation for NASA's program of planetary exploration from spacecraft. The emphasis is on the following atmospheric science goals: (1) determine the thermal structure and its spatial and temporal variability in the terrestrial and outer planets; (2) map the abundance and vertical, lateral and temporal variability of key atmospheric species; (3) measure, by direct and indirect means, atmospheric motion; and (4) determine the physical properties of clouds and aerosols. The investigation of surface phenomena is also of fundamental importance in the rational development of infrared instrumentation. In particular our objective is the application of infrared remote sensing to the identification of surface materials, determination of surface cooling rates, thermal inertia measurements and the mapping of surface morphology. The approach will be to develop in the laboratory the critical hardware for an advanced infrared sounder. This development instrument is both versatile in the science goals which it can address and is sufficiently flexible to permit its use in future terrestrial and outer planet flight opportunities. To undertake this task we have at JPL an experienced infrared experiment team with expertise in hardware development, atmosphere and surface studies and data analysis techniques.

W82-70516 **154-90-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY ATMOSPHERE EXPERIMENT DEVELOPMENT
H. B. Niemann 301-344-8706

The objective of this work is to develop instrumentation and necessary specialized test and calibration techniques for in situ neutral gas and ion composition and density measurements in planetary atmospheres. The instrument development is focussed on neutral gas and ion mass spectrometry. Different atmospheric environments encountered in various planetary missions as well as the different scientific goals set for the studies of the planets require instrument performances which are highly mission specific. Work will be done in four areas: (1) Mass Spectrometer Sensor

Development. Ion source efficiencies will be optimized for operation in high particle velocity regimes (more than 50 km/sec.). High pressure ion source and large dynamic range analyzer systems will be developed for trace gas detection; (2) Sample Inlet Systems. Compact gas leaks for pressure reduction from high pressure atmospheres to ion source operating levels and sample enrichment techniques for trace gas analysis will be developed; (3) Calibration and Test Equipment. Intermediate velocity molecular and atomic beam systems and trace gas mixing systems will be developed to simulate expected planetary and cometary atmosphere conditions for evaluation of instrument performance and calibration; and (4) Electronics System. Advanced digital logic and analog control circuits for onboard data processing using microprocessor.

Mars Data Analysis

W82-70517 **155-04-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERES DATA ANALYSIS
J. B. Pollack 415-965-5530
(154-10-80; 154-20-80; 154-30-80)

The basic objective is to relate spacecraft and ground based observations of planetary atmospheres to theoretical models. Mariner 9 and Viking data have yielded information on the structure, meteorology, and aerosol content of the Martian atmosphere. A Martian atmosphere general circulation model will be utilized to aid in interpretation of data taken during the extended Viking mission and to assess the dynamical effects of suspended dust particles. In addition, one and two dimensional models will be employed to simulate diurnal and seasonal cycles of water vapor and carbon dioxide. These models will then be analyzed to determine aerosol optical depth and thus provide a long term record of this key quantity.

W82-70518 **155-04-80**
Jet Propulsion Laboratory, Pasadena, Calif.
MARS ATMOSPHERIC OPACITY STUDIES
Terry Z. Martin 213-354-3111

The routine developed by Martin and Zurek to derive infrared opacities of the Mars atmosphere from Viking infrared thermal mapper (IRTM) data will be applied to: (1) generate opacity maps for GCM dust storm simulation; (2) characterize the global opacity in 'clear' periods optimal for study of surface phenomena; (3) determine if dust transport can be established by use of sequential opacity maps of given areas; and (4) generate an opacity history of Mars over the Viking observed period. A parallel task will generate a time longitude data base of IRTM 15-micrometers temperatures to benefit a study of planetary waves in the Mars atmosphere.

W82-70519 **155-20-40**
Lyndon B. Johnson Space Center, Houston, Tex.
MARS DATA ANALYSIS PROGRAM
W. C. Phinney 713-483-3816

The objective of these studies is to provide data on the physical and chemical processes which could have produced rocks and soils on Mars. These data should provide a basis for interpretation of the existing remote chemical, physical, and geological data from Mars, particularly those provided by the Viking Mission. The studies will use a variety of theoretical, experimental, analytical, and analog techniques to obtain these data. The approach will be to use experimental simulations to quantify the effects of weathering the properties of rocks, soils, and minerals, and to use terrestrial analogs of Martian surface structures to help constrain evolutionary models of Mar's crust. A wide range of analytical techniques will be used to characterize the physical and chemical properties of materials.

W82-70520 **155-20-70**
Jet Propulsion Laboratory, Pasadena, Calif.
JPL GEOCHEMISTRY AND GEOPHYSICS MARS DATA ANALYSIS
Thomas C. Duxbury 213-354-6106

This RTOP includes JPL MDAP tasks in the Geophysics and Geochemistry Program. Tasks are being performed in a variety of disciplines, including studies of gravity and internal structure, atmospheric absorption into the regolith and photometric and thermophysical properties of the surface of Mars and its satellites, as well as geodetic and dynamical studies of the satellites.

W82-70521 **155-41-80**
Jet Propulsion Laboratory, Pasadena, Calif.
JPL ASTRONOMY MARS DATA ANALYSIS
John D. Anderson 213-354-3956

Radio tracking of the Viking Mars mission orbiters and landers have provided a wealth of radio science data. Much of these data remain to be analyzed. Viking Lander radio data continue to be transmitted and provide an opportunity for additional scientific return. This RTOP will: (1) continue the acquisition of Lander Doppler and range data in support of radioscience investigations, both at JPL and elsewhere; (2) utilize Lander data to improve the orbits of Mars and the Earth, determine Mars spin and precession (including seasonal effects), estimate the masses of several asteroids, and limit a possible time variation in G; and (3) analyze orbiter radio signals to study the solar corona and solar wind.

W82-70522 **155-50-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA REPRODUCTION IN SUPPORT OF THE MARS DATA ANALYSIS PROGRAM
James I. Vette 301-344-7354
(404-03-01)

The NASA Headquarters Planetary Division has approximately 110 Principal Investigators. Many of these, in addition to a number of other planetary scientists, are participating in the Mars Data Analysis Program. Many of these investigators require large quantities of data, especially photographic products to achieve the objectives of their investigations. Such products are only generally available through the National Space Science Data Center (NSSDC). While the size of these NASA supported requests would normally result in NSSDC's having to charge for services, such funds from university and other nongovernmental investigators would go to the U.S. Treasury. Therefore these funds would not allow NSSDC to purchase the required photographic supplies or pay contractor labor. On the other hand, the existing budget would not allow NSSDC to supply these investigators with the required data and carry out its normal request activity. For example, NSSDC has received practically all the Viking images and is receiving the Voyager images. Regional libraries require a complete set of prints and negatives. These additional requests cannot be satisfied within the existing NSSDC budget.

W82-70523 **155-50-01**
Jet Propulsion Laboratory, Pasadena, Calif.
JPL GEOLOGY MARS DATA ANALYSIS
David E. Thompson 213-354-6129

This RTOP supports two general aspects of Mars data analysis. First, analog studies are carried out to understand processes and physical interactions occurring in the Martian surface environment. These tasks are theoretical, experimental, and field analog in nature. Theoretical and experimental work is being carried out on the thermophysical and geochemical properties of Martain soil models. This information reconfirms or enhances understanding and interpretation of Viking and Mariner radiometric observations. In addition, theoretical and field analog studies are being conducted on the geomorphic processes which shape the martian outflow channels and the sediment transports relations operative in major catastrophic flooding events, akin to those believed to have occurred on Mars. All of this work is ultimately constrained and tied back to relevant Viking data, both from landers and orbiters. The second aspect of this RTOP, then, is an effort to analyze the reliability of that data and to monitor changes at the lander sites. In particular, analysis includes

estimates of spectral reflectance and optical depth determination, and a major effort to identify and correct orbiter imaging errors, to reduce and document imaging data, to maximize data search techniques to make an accurate data base available to the scientific community, and to maintain operations of the Viking 1 Lander imaging experiment.

W82-70524 **155-50-01**
Lyndon B. Johnson Space Center, Houston, Tex.
MARS DATA ANALYSIS PROGRAM GEOLOGY
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface processes is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data as well as place boundary conditions on planetary evolution. The study of appropriate analogues not only places boundary conditions on the evolution of Mars but also permits on Earth the evolution of the characteristics of Martian surface instrumentation. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogues of Martian surface material. Specific objectives are: (1) to characterize the gases released by thermal decomposition of Martian surface analog materials and evaluate the feasibility of accomplishing such analyses in situ; and (2) to simulate the mechanical, chemical, and radiative weathering environments on Mars study in detail the resulting products of materials subjected to such conditions.

Instrument Development

W82-70525 **157-01-70**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CCD CAMERA DEVELOPMENT
Robert J. Wilson 213-354-2558

Previous work on visual CCD development has led to the current activity to provide 800 x 800 element devices for several space flight imaging programs. These devices look like they will perform well, but have several limitations that currently restrict their use. A new device technology has been developed recently that presents an opportunity to overcome some of the most significant limitations of the current 800 x 800 CCD and at the same time allow the development of even larger array devices. This single phase CCD approach has already been demonstrated and is currently ready for development as a scientific sensor. The activity to develop the chip is being supported both by this RTOP and OAST. To both evaluate the device and develop the supporting electronics expertise required in advance of flight mission use, a camera development and developmental sensor testing activity is needed. This camera development will happen in conjunction with the device development and will provide the initial electronics design, the camera testing, and the camera/CCD characterization needed for both effective chip development and future imaging mission support. The need for large area device CCD cameras continues to grow, and the performance and producability of the current devices are limited. This camera development will open up availability to a much larger community and provide a larger area device.

W82-70526 **157-02-70**
Jet Propulsion Laboratory, Pasadena, Calif.
MINIPROBE
Arden L. Albee 213-354-6057

This RTOP supports the development of a miniaturized Scanning Electron Microscope and Particle Analyzer (SEMPA) as a potential flight instrument for inclusion on any mission capable of sampling a planetary body or cometary dust. While such instruments are now commonplace in laboratories and have proven their value, for space applications the size, mass, and power requirements must be reduced while reliability and degree of automation must be enhanced. To this end, a breadboard instrument has been designed, fabricated, and assembled. In the continuation of the task, the performance of the electron optical system will be tested, and design specifications modified if needed. Geometries for redundant electron emitters will be tested. The effects of temperature on three types of X-ray detectors will be examined, from which specifications will be developed for detector cooling. Three types of electron detectors will be tested in order to arrive at specifications for SEM imaging functions. X-ray analytical capabilities will be developed along with software protocols for automated operation of the instrument. Response to physical and thermal stresses will be studied, and finally, specifications for a technically feasible flight-qualified instrument will be developed.

W82-70527 **157-03-40**
Lyndon B. Johnson Space Center, Houston, Tex.
MASS SPECTROMETRY-ISOTOPE DILUTION (MSID) EXPERIMENT DEVELOPMENT
L. E. Nyquist 713-483-5579

This RTOP is to continue definition of the Mass Spectrometry-Isotope Dilution (MSID) experiment for future use in the analysis of planetary materials by unmanned spacecraft. The probable first application of the instrument would be analysis of cometary dust collected during close rendezvous with a short period comet. The approach adopted has been to begin definition of the sample processing system (SPS) which prepares the sample for mass spectrometry. Simultaneously, a small mass spectrometer which could be used for the flight instrument will be set up utilizing available equipment where possible. The development of individual components of the SPS is prioritized, and development of the three highest priority items is being jointly undertaken by JSC's Planetary and Earth Sciences and Experiment Systems Divisions and their support contractors. In case development, progress is faster than anticipated, the level of effort will be maintained to continue definition of SPS components in order of priority.

W82-70528 **157-03-50**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY GAMMA-RAY AND NEUTRON-GAMMA-RAY METHODS FOR PLANETARY EXPLORATION
J. I. Trombka 301-344-5941

The objective of this investigation is to develop instrumental systems for remote measurements of the spectra of X-ray, and gamma ray emissions from planetary, asteroid, and cometary bodies. These measurements will be used to obtain geochemical and geophysical information concerning such planetary bodies. The X-ray spectrometer study will consider both proportional and solid-state detectors. Elemental composition for elements with atomic numbers greater than z = 6 (carbon) using solar X-ray fluorescent spectral measurements are being considered. Both theoretical and experimental studies will be used in the investigative program. X-ray fluxes produced by electron acceleration by ionosphere-solar wind interactions and by crossing sector boundaries will be calculated. The temporal and energy distributions and the flux intensities will be estimated. Once solid state detector systems are considered for the X-ray spectrometer, the possibility of combining the X-ray and gamma ray solid detector system presents itself. Such a combined remote sensing system may decrease the weight and spacecraft interface complexity by using a common cryogenic system and central data processors. This investigation will be carried out in cooperation with groups at the Jet Propulsion Laboratory and the University of California, San Diego.

W82-70529 **157-03-51**
Goddard Space Flight Center, Greenbelt, Md.
KNUDSEN CELL FOR CHEMICAL COMPOSITION OF DUST
H. B. Niemann 301-344-8706

The object of this work is to develop an engineering prototype Knudsen cell device, which will mate with the comet rendezvous mass spectrometer. It collects and pyrolyses comet dust for analysis by the mass spectrometer. This instrumentation is also applicable to analysis of micrometeorites and the ice and dust in planetary ring systems. The development of this instrument centers around the cell which must be designed to accommodate the predicted dust density in the comet coma and tail. The

pyrolysis must be done so that the equilibrium established between the solid and its vapor phases is maintained at sufficient pressure for sufficient time to permit adequate mass spectra to be obtained. Development is required in four areas: (1) cell design based on predicted dust densities around the comet; (2) determination of optimum dust loading and pyrolysis heating cycles; (3) construction of a beaming system to prepare known clathrates; and (4) design of Knudsen cell hardware, cell heater system, heat shields, shutters, cell closure device, gas guides or collimation, mating connection to mass spectrometer source, etc.

W82-70530 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY INSTRUMENT DEFINITION
Albert E. Metzger 213-354-4017

The objective of this RTOP is to develop a state-of-the-art gamma ray spectrometer. A central cooler capable of servicing any planetary instrument requiring temperatures from 70 degrees to 160 degrees Kelvin with heat loads on the order of a watt or less is proposed as a future task.

Solar Terrestrial SR&T

W82-70531 **159-41-01**
Jet Propulsion Laboratory, Pasadena, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTORS FOR ASTRONOMY APPLICATIONS
Paul N. Swanson 213-354-3273
(540-01-15)

The objective of this RTOP is to develop a conceptual design for a large (10-30 m diameter) deployable parabolic reflector (LDR) for use in submillimeter and far infrared astronomy. Such a telescope is intended to provide high angular resolution and large collecting area in a wavelength range in which ground based observations are prevented or gravely impeded by atmospheric absorption and emission. It will complement in capability ground based telecopes for adjacent wavelength ranges (millimeter, near infrared) now operating or planned for the next decade. While astronomy provides the prime motivation for this RTOP, other applications may exist in space communications and remote sensing. The fact that this program is based strongly on technology developed with DARPA funding is evidence of other potential applications. The approach, in cooperation with the Ames Research Lab, will be to refine the existing design, which has emerged from the Lockheed study and work at JPL during FY 80 and 81. In particular, the material and design of the reflector segments must be determined since it impacts almost all other aspects of the telescope. Other subsystems such as pointing, figure control, structure and surface measurements will be looked at in more detail by an interdisciplinary design team. Both technology and science workshops will be convened in FY 82 so that the design can be evaluated by experts working in related areas and by scientists who may be eventual users.

W82-70532 **159-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
ORBITING VERY LONG BASELINE INTERFEROMETRY (VLBI)
J. F. Jordan 213-354-7790

The objectives of this RTOP are to delineate the scientific goals and systems for the space applications of very long baseline interferometry (VLBI) and define an experiment using an orbiting antenna and an appropriate ground network, for demonstrating the astronomical VLBI potential of spaceborne systems. A study team has been formed, including personnel from MIT (Prof. B.F. Burke, P.I.), MSFC, and JPL to develop requirements and preliminary design concepts for an orbital VLBI terminal to be carried by the shuttle. This work will be coordinated with MSFC's existing R&D on large spaceborne antenna structures. Scientific (Co-I) and engineering support will be provided to the P.I. for design of the experiment and will develop needed technical requirements data as outlined below. Earlier proposals and studies have outlined the potential of VLBI using baselines including an orbital terminal. Not only does this permit baselines longer than the size of the Earth (hence higher angular resolution), it also permits baselines varying in such a way as to give greatly improved and faster mapping coverage of celestial radio sources. The object of the present work is to quantify these advantages, and demonstrate their possible achievement in both early spaceborne antenna tests and eventual VLBI Earth orbiting observatories. The work will begin by investigating an implementation mode using the proposed MSFC large antenna demonstration flight.

Astrophysics SR&T

W82-70533 **188-36-55**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLES AND PARTICLE/FIELD INTERACTIONS
Keith W. Ogilvie 301-344-5904

The object of this research is to increase the knowledge and understanding of nonthermal plasmas occurring in the interplanetary medium and magnetospheres of Earth and other planets. This requires continuous improvement of measurement techniques, concentrating on advanced concepts for plasma particle distribution spectrometers, magnetometers and radio and plasma wave analyzers. Work is also underway to improve the theoretical description of plasma properties, and to improve techniques for the interpretation of the results of space plasma observations, requiring corresponding improvements in numerical techniques and in methods of data display.

W82-70534 **188-36-55**
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTION
A. Barnes 415-965-5506
(384-47-67; 385-36-01)

The overall objective is to investigate the solar wind, its origin, termination, dynamics, and turbulence, as well as its interaction with planetary obstacles. Theoretical studies will be conducted, aimed at understanding the large scale dynamics of the solar wind, its acceleration and heating mechanisms, and waves and turbulence in the solar wind. These studies employ known theoretical techniques of plasma physics and magnetohydrodynamics, and also often require extensions of basic theoretical plasma physics. Theoretical developments will be related to spacecraft plasma and magnetic data, as well as to indirect observations of the solar wind. Theoretical studies of possible relations between variations in solar output (radiation and/or charged particles and magnetic fields) and terrestrial weather and climate will be carried out. Theoretical studies of the solar wind/Venus interaction will be conducted.

W82-70535 **188-36-55**
Jet Propulsion Laboratory, Pasadena, Calif.
MAGNETOSPHERIC PHYSICS: PARTICLES AND PARTICLE/FIELD INTERACTIONS
Bruce E. Goldstein 213-354-7366

The vector helium magnetometer is being developed further for use on future space missions. Magnetometers on spacecraft orbiting the planets (especially the outer planets) or approaching the sun will need high sensitivity to detect small fluctuations in the presence of large background fields. Furthermore, high relative motion between the spacecraft and moving bodies (such as comets) will require rapid sampling by an instrument with a correspondingly large bandwidth. These and other improvements will be achieved by analysis and tests to find the means to meet those requirements. The objective is to advance our understanding of space plasma physics and to provide continuing theoretical support for observational space plasma programs. Work is to be performed in four areas: (1) the solar wind electron distribution and thermal conductivity; (2) critical differences between the physical processes of the magnetospheres of the Earth and Mercury; (3) magnetostatic equilibrium models of the force balance within the magnetosphere for magnetically open models, and (4) models of the solar wind interaction with a

cometary ionosphere. Calculations will be done on a pulsed maser theory of Jupiter and terrestrial pulsed radio emission and a theory of the interaction of the radio source region in the lower magnetosphere with the upper ionosphere. Nonthermal plasma wave and particle distributions will be derived from the theory when predicted and observed burst waveforms and dynamic spectra are compared. Derived fluxes will predict auroral image and spectral data. The objective is the education of the general public about interplanetary research. There are no good, nontechnical references on the subject. The work performed under this RTOP will culminate in publication of a popular level (no equations) book which describes (1) the contents of and processes which occur in interplanetary space, (2) the interaction of the interplanetary medium with the planets, comets, and spacecraft, and (3) the relevance of research in interplanetary physics.

W82-70536 **188-36-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE AND PARTICLE/PROTON INTERACTIONS (ATMOSPHERIC MAGNETOSPHERIC COUPLING)
James P. Heppner 301-344-8797

The objective is to develop experimental and theoretical approaches for investigating the processes which provide strong coupling between the neutral atmosphere, the collision-dominated ionospheric plasma, and the collisionless magnetospheric plasma. Within the framework of this overall objective, specific subobjectives are identified in terms of having: (1) key significance; (2) goals which are attainable with limited resources; and (3) close ties to future projects and programs. Emphasis is placed on the primary forces, electric fields and neutral winds, and the associated transport and energization of particles. Related topics include: electric fields in the Earth ionosphere cavity and their relation to weather processes, electric current systems and associated magnetic field disturbances, the generation of thermospheric winds and gravity waves, atmospheric chemical composition anomalies, the transformation of atmospheric ions to trapped radiation, auroral particle acceleration mechanisms, plasma instabilities producing ionospheric irregularities, etc. New instrumentation is being developed for observing tracer chemicals and for measuring of low energy particles. Properties of double probes in low density plasmas are being studied with the SCATHA satellite. Models for the diffusion of tracer particles are to be developed for planning future chemical release experiments. The closure of magnetospheric electric fields within the Earth ionosphere cavity is to be studied in support of low and middle atmosphere electric field investigations.

W82-70537 **188-36-57**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ACCELERATOR FACILITY: MAINTENANCE AND OPERATION OF A CALIBRATION FACILITY FOR MAGNETOSPHERIC AND SOLAR-TERRESTRIAL EXPERIMENTS
James H. Trainor 301-344-6282

The Goddard Space Flight Center sciences directorate operates a nuclear particle calibration facility consisting of a 2 MeV Van de Graaf and a 250 keV electrostatic accelerator. The facility provides particle energies from 50 eV to 2 MeV, and protons via reactions to 20 MeV. Particle beams available range from electrons to Kr84, with fluxes from approximately 1 particle/sq cm sec to approximately 109 particle/sq cm sec. It has been a unique facility in the world in this low energy region. Some of its abilities are now duplicated by an accelerator at MPI Lindau. For several years, all work in this facility has been in support of magnetospheric and solar terrestrial research. Over the past four years, machine time has been split fairly evenly between calibration and testing of satellite experiments, testing and development of new particle detector systems, and numerous sounding rockets payloads. Requests from foreign experiments amount to 5 to 15 percent of the machine time. The facility operates normally on all working days, but the requirements of the experiments in the past several years have often required operation 6 or 7 days per week and 12-16 hours per day at times. That, coupled with the declining manpower in Code 660, has forced the facility to rely heavily on contractor manpower for maintenance and operation.

W82-70538 **188-38-51**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF EXPERIMENT AND HARDWARE
J. H. Underwood 213-354-7375

The ultimate objective of this program is to advance the physical understanding of the upper atmospheres (chromosphere, transition region and corona) of the Sun and solar like stars. To this end, new instrumentation is being developed for two purposes: (1) to image the Sun with ultrahigh spatial resolution in the soft X-ray and extreme ultraviolet (EUV) spectral regions (lambda < 300 A); and (2) to improve spectroscopic measurements in this region, in particular in the relatively unexplored band 25 A $<$ lambda $<$ 170 A. This new instrumentation is based on the new technology of the fabrication of X-ray/EUV reflectors by vacuum deposition. These reflectors, which may be viewed either as mirrors reflecting a specific band of wavelengths or as 'artificial crystals' acting as Bragg diffractors, are composed of two material arranged in ultrathin alternating layers of uniform thickness. The resulting periodic structure is exactly equivalent to a quarter wave stack in ordinary optics, and reflects X-rays according to the Bragg relation. With the new instruments it will be possible to make plasma diagnostic measurements with a spatial resolution much smaller than existing instrumentation allows. Hence it will be possible to study the size scale over which the dominant energy input and transport mechanisms in the upper solar atmosphere are effective. Under this task, a prototype instrument will be developed for flight on a rocket.

W82-70539 **188-38-51**
Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
M. J. Hagyard 205-453-0118

The objective of this program is to develop an engineering design of a flight experiment to measure very small variations in total solar flux as a new technique for critical study of the dynamics of convection and magnetic fields in the solar convection zone. The approach is through development of an instrument, a Crystal Cavity Radiometer (CCR), which uses the extreme stability of oscillation of a quartz crystal as a sensitive indicator of changes in solar irradiance.

W82-70540 **188-38-52**
Marshall Space Flight Center, Huntsville, Ala.
GROUND-BASED OBSERVATIONS OF THE SUN
M. J. Hagyard 205-453-0118
(385-38-01)

The objective of this research is a program of ground-based observations for basic research concerning solar vector magnetic fields and for support of NASA solar missions using the facilities of the MSFC Solar Observatory. In the program for basic research, a theoretical and observational program will be initiated to study: (1) magnetic transients and their relevance to solar maximum mission (SMM) flare analyses; (2) magneto-optical effects in measurements of transverse magnetic fields and their implications for Spacelab/Solar Optical Telescope (SL/SOT) filter magnetograph observations; (3) the vector morphology of the solar network field to provide coarse boundary conditions for theorists modeling the role of solar convection in solar dynamo theories; and, in general, (4) problems facing designers and scientific users of ground-based and spaceborne vector magnetographs.

W82-70541 **188-41-51**
Goddard Space Flight Center, Greenbelt, Md.
UV AND OPTICAL ASTRONOMY
A. Boggess 301-344-5103

The objective is to pursue a long range program in astronomical research with emphasis on detector and instrumentation development, theoretical astrophysics relevant to the interpretation of space observations, and other specific topics of special interest to NASA. The effort includes operation of ground telescopes, evaluation of new instrumentation for potential space application, and development and evaluation of detector systems that are candidates for space flight. In the course of evaluating detectors and instruments, spectroscopic and photometric data are obtained from ground telescopes concerning the properties of stellar

atmospheres, nebulae, the interstellar medium, and galaxies. Non-equilibrium model atmospheres are being investigated to interpret spectral observations from space observatories. Theoretical investigations are carried out regarding the information and evolution of galaxies and on the evolution of stellar interiors, variable stars, novae, and planetary nebulae.

W82-70542 **188-41-51**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF GALAXIES, ACTIVE GALACTIC NUCLEI, AND QUASI STELLAR OBJECTS
L. J. Caroff 415-965-5536

The objective of this work is to conduct theoretical studies on important fundamental problems in the development of density inhomogeneities in the post--radiation dominated Universe and the subsequent formation and evolution of galaxies, and in the structure and dynamics of quasars and active galactic nuclei. Much of the effort falls under the aegis of computational astrophysics, making use of existing numerical codes for hydrodynamics and radiative transfer as well as developing new ones. An important aspect of this area of study is the development of a general method for modeling random phenomena, which will have wide application to many areas of astrophysics.

W82-70543 **188-41-51**
Jet Propulsion Laboratory, Pasadena, Calif.
UV AND OPTICAL ASTRONOMY
Wesley T. Huntress 213-354-2140

The first task of this research involves laboratory work to measure products and rate constants for ion-molecule reactions leading to the synthesis of interstellar molecules. This work provides data to help interpret the abundance of observed interstellar molecules, and to predict new species. The data are used in models of interstellar clouds in order to describe molecular evolution in astrophysical environments. Another task includes laboratory measurements to determine electron impact emission cross sections and oscillator strengths of importance in modeling emission and absorption features originating from stellar, quasar, and interstellar sources in the UV and EUV spectral region. These measurements will be used in analyzing emission line intensities and equivalent widths of absorption lines in order to derive information concerning the atmospheric layers (temperature and density) producing the line and in analyzing relative line intensities to determine stellar abundances and temperatures. In addition laboratory measurements will be performed to provide electron impact excitation cross sections and UV photoionization cross sections of cosmically abundant atoms and molecules for stellar modeling. Experimental electron/photon cross section data are needed in the detailed balance equation to model the non LTE conditions of stellar atmospheres, gaseous nebulae, and interstellar clouds. Electron scattering cross sections will be measured for CII, MgII, AlII and SiI. These ions serve as important diagnostics of the galactic environment. Measurements will be made for both resonance and optically-forbidden transition and, where appropriate, comparisons made to the Gaunt factor predictor approximation for obtaining electron collision strengths. Production and loss mechanisms and abundances of molecules in normal and shocked interstellar clouds and in circumstellar envelopes are calculated. Coupled chemical kinetic equations of atomic and molecultar species are solved simultaneously with equations of heat balance. For shocked conditions the profiles of density, temperature, and radiation field are taken from independent calculations.

W82-70544 **188-41-55**
Goddard Space Flight Center, Greenbelt, Md.
INFRARED AND SUB-MILLIMETER ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-54; 389-41-01; 154-50-80)

The scientific objective of this program is to provide a better understanding of the current state and evolution of astronomical objects. This is achieved by observations at wavelengths from 1 micron to 1 mm and at spectral resolution (lambda over delta lambda) from 1 to 10 to the 7th power. Since atmospheric opacity and emissivity prohibit or severely limit ground-based observations at certain wavelengths, high altitude observational platforms such as the C-141, balloons, or satellites must be used. High sensitivity composite bolometers are being developed in the far infrared to take maximal advantage of low background conditions achievable at these altitudes. A balloon-borne 1.2 m telescope is used to conduct a photometric survey of galactic sources of submillimeter radiation, and at least a partial survey of extragalactic sources at these wavelengths. An infrared sky camera is also used to quickly map various sources. Infrared and submillimeter coherent (heterodyne) spectrometers are developed and used to measure completely resolved intensity profiles for neutral and ionized molecular and atomic lines. Correlative studies are made when possible to enable maximum insight into the physics of the medium.

W82-70545 **188-41-55**
Ames Research Center, Moffett Field, Calif.
THEORETICAL INFRARED AND RADIO ASTROPHYSICS
D. C. Black 415-965-5495

The objective of this work is to conduct theoretical studies of fundamental problems in astronomy and astrophysics with emphasis on phenomena susceptible to observational study at infrared and/or radio wavelengths. Specific problem areas to be considered are star formation, structure and evolution of dark clouds, and interstellar shock waves. The star formation studies are conducted by means of numerical experiments using multi-dimensional hydrodynamic computer codes. The dark cloud work is conducted by means of detailed numerical modeling of observable properties (e.g., molecular line widths) and comparison with available data. The shock wave work is conducted by means of a one-dimensional hydrodynamic computer code to determine shock properties, coupled with predictions of line intensities which will be compared with observational data.

W82-70546 **188-41-55**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO ASTRONOMY
Samuel Gulkis 213-354-5708
(188-41-51; 358-78-60; 540-01-15)

The lab program will continue to expand the spectral line catalogue, which currently includes 91,000 transitions from 133 species. Experimental and theoretical work will continue on the NH2 radical, and the feasibility of making measurements on metal hydrides will be investigated. A far-IR laser which operates in the 600 to 3000 GHz range will be integrated into the laboratory to measure lines of OH, NH2 and other radicals. The pulsar rotation constancy task will continue to measure the fluctuations in the rotation rate of selected pulsars and to measure their positions and proper motions by recording the pulse arrival times at regularly space epochs. The spectroscopy observations task will concentrate on research in interstellar and circumstellar chemistry using the NASA 64-m antennas at Goldstone and Tidbinbilla. The latter facility will emphasize the Magellanic clouds and the galactic center. Under the new fiscal guideline, development of JPL mm receivers for ground-based observations can no longer be supported but guest mm observations will be carried out at national and university observatories with emphasis on areas of mutual interest to the lab program and JPL's interstellar chemistry program. In the K-band maser task, some limited development and analysis of the results of the first balloon flight to measure the isotropy of the cosmic background radiation is planned. The Tidbinbilla task will continue to carry out position measurements in the Southern Hemisphere with an ultimate objective of obtaining optical identifications of radio sources. The interferometer, which utilizes the 34-m and 64-m antennas of the Deep Space Network at Tidbinbilla, Australia, provides a unique capability in the Southern Hemisphere. The Space Telescope will be able to make use of the radio positions and optical identifications provided by this program.

W82-70547 **188-46-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ASTROPHYSICS AND SHUTTLE EXPERIMENT DEFINITION
F. B. McDonald 301-344-8801

The objective is to study the properties of the cosmic radiation in order to understand its origin and propagation, and to study

the properties of the sites in which element synthesis takes place. The particles observed are the nuclear and electronic species of the cosmic ray particles. Among their key characteristics are their charge and isotopic composition, and their distribution in space. Some of these objectives can be met through the imaginative use of short duration observations on balloons. Many will require heavier, larger area payloads for which the space shuttle will be an ideal observation platform especially in the sortie mode. The details of the chemical composition of the particles as a function of energy is intimately related to the propagation process and must be completely understood in order to determine the cosmic ray path length distribution and hence, the spatial distribution, of cosmic ray sources. In addition, this will determine the injection spectrum of cosmic ray nuclei. The high energy composition measurements are essential in order to determine the source abundances of the rarer cosmic ray nuclei. Measurement of isotopic composition will enable us to probe the process of nucleosynthesis which take place in the cosmic ray sources.

W82-70548 **188-46-57**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY ASTRONOMY
C. E. Fichtel 301-344-6281

The technical objective is to develop the most appropriate detector systems for the observation of the astrophysical sources of very energetic photons. The first approach is the development of a large area high energy telescope using digitized spark chambers. Many major improvements to this basic telescope system are still being pursued and other approaches to detector systems are now being developed for the high energy, intermediate energy, and low energy gamma-ray observations. In the medium energy interval (8 to 50 meV), a second generation experiment has now been flown on a balloon. In the 1/2 to 40 MeV region different detection processes become dominant, and hence, new detector techniques are required. A totally new detector is currently being built based on the Compton interaction process. In the 0.03 to 10 MeV region, much of the radiation may consist of monoenergetic line components; therefore, high resolution spectrometers are also being developed which will be capable of sufficient precision to resolve lines as narrow as may be found in nature. In the high energy region, improvements in the track imaging chamber systems are continuing, and special attention in the track imaging chamber research is now being directed towards drift chambers and larger spark chambers. At the same time, several approaches are being explored to improve angular resolution, including techniques to concentrate on higher energy photons. Improved attitude and aspect systems are being built.

W82-70549 **188-46-59**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY ASTRONOMY
E. A. Boldt 301-344-5853

Celestial X-ray sources have introduced rich new aspects of astronomy ranging from the millisecond bursts of hard X-rays coming from the innermost orbits of matter falling into a black-hole to the beamed emission associated with accretion of matter onto a rapidly rotating highly magnetized neutron star. The combination of large sensitive area, low detector background, high temporal resolution and nondispersive spectroscopy over a broad bandwidth has been our approach in discovering and exploring these phenomena. The power of this approach is being well demonstrated. Extending it with improved spectral resolution and broadband imaging is a major area of development now indicated. This involves the creation and evaluation of new systems incorporating low noise ionization counters of optimum resolution, large area X-ray concentrators and imaging devices such as deep diode arrays. Dispersive spectroscopy is being introduced via the development of a conical crystal spectrometer used for measuring line structure.

W82-70550 **188-78-51**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED TECHNOLOGICAL DEVELOPMENT, GENERAL: SIGNAL AND DATA PROCESSING ELECTRONICS; SOLID STATE DETECTORS
James H. Trainor 301-344-6282

The objectives of this research project are to develop and test new onboard signal handling, data processing, storage, computing and auxiliary electronics circuitry for use in energetic particle and astrophysics experiments on spacecraft, rockets, balloons, etc., as well as special test and analysis equipment applicable also for both ground and shuttle usage. The growing complexity of experiments and the often corresponding increase in the volume of data obtained have made signal handling, data processing and data transmission capability limiting factors. To reduce the transmission of unnecessary data, it is necessary to increase the experiment's onboard signal handling and data processing capability. Further objectives are to: (1) investigate and develop new techniques for signal shaping and handling, data processing, and auxiliary circuitry; and (2) the modify existing techniques through the application of advanced technology and materials including MOS/LSI technology, thick film techniques, multiple chip techniques and microprocessors.

W82-70551 **188-78-60**
Jet Propulsion Laboratory, Pasadena, Calif.
GRAVITATIONAL EXPERIMENTS IN SPACE
John D. Anderson 213-354-3956

Radio tracking of Mariner, Viking, Pioneer, and Voyager spacecraft have provided a wealth of data for testing general relativity and for placing a bound on the cosmic background of gravitational radiation. The primary objective of this RTOP is to evaluate the current status of experimental gravitation in general, but in particular in space, and to produce guidelines on the types of solar system experiments to perform in the future. A few possible space missions will be studied with regard to cost, feasibility, technological requirements, and overall attractiveness to the space science community. These include Starprobe, Mercury Orbiter and/or Lander, and inexpensive missions to the near interstellar medium. An annual status report will be issued on the subject of this RTOP, and it will be given a wide distribution within NASA and the space science community.

Planetary Astronomy

W82-70552 **196-41-40**
Lyndon B. Johnson Space Center, Houston, Tex.
REMOTE SENSING OF PLANETARY SURFACES
A. E. Potter 713-483-5039

The objectives of the RTOP are to identify and map silicates on the lunar surface, using silicate reststrahlen bands in the thermal emission spectrum of the Moon, and then to extend this technique to identification of silicates on Mercury, near Sun comets, and asteroids. Silicates will also be mapped on the lunar surface using multispectral imagery in the near infrared (0.8-2.4 micron). A Michelson interferometer and ground based telescopes are used to measure lunar spectra of small (2-3 arc sec) lunar areas with signal to noise ratios in excess of 500:1. Spectra are ratioed to the spectrum of a standard site (Apollo 11) to cancel atmospheric and instrument effects. The resulting ratio spectra are corrected for temperature differences between the sites, and compared with mineral powder emission spectra calculated from theoretical models. Spectra in both the 8-14 and 16-24 micron atmospheric windows will be obtained from the ground based measurements. In future work, it is planned to obtain spectra over the 6-50 micron range using a cooled prism spectrometer with the Kuiper Observatory. An imaging Michelson interferometer is used to collect near infrared multispectral image data, which are to be analysed by statistical methods.

W82-70553 **196-41-50**
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED INFRARED ASTRONOMY
V. G. Kunde 301-344-5693
(188-41-55; 154-50-80)

The scientific objective is to determine information on astrophysical objects, such as molecular clouds, interstellar lines, molecular and circumstellar components in stellar atmospheres, and planetary atmospheres from high spectral resolution ground based measurements in the intermediate infrared. A spectrometer system employing a cryogenic Michelson interferometer (77 K) is being developed to meet the simultaneous requirements of high spectral resolution, a wide free spectral range and high sensitivity. An optical retardation up to 25 cm will provide an unapodized spectral resolution up to .02/cm in the 400-2000/cm range. A post dispersed detection system is being developed to reduce background noise from a warm telescope system and the atmosphere at the detector; thus allowing the multiplex advantage of the interferometer to be retained. The cooled instrumentation with the post dispersed detection system, operating at a favorable infrared site, will allow maximum sensitivity to be attained for an interferometer system at a ground based site. The sensitivity level for a measurement in the 1000/cm (10 micrometers region with a 122 cm diameter telescope, an integration time of 60 minutes and a spectral resolution of 0.2 cm is approximately 5 x 10 to the minus 26th power watts/sq m/Hz. The signal to noise level for Jupiter in the 1000/cm region with the above system is approximately 7 for one minute integration time and full spectral resolution of 0.02/cm. Initial observations will be made during FY82 with a discrete detector system with sensitivities approximately 5-10 lower than for the post dispersion system.

W82-70554 **196-41-52**
Goddard Space Flight Center, Greenbelt, Md.
IMAGING STUDIES OF COMETS
John C. Brandt 301-344-8701

This RTOP provides for the operation of a small high altitude observatory, joint observatory for cometary research (JOCR), for imaging research on comets and their interactions with solar radiation and the solar wind. This research is carried out with ground based images alone or if suitable data from spacecraft such as Solar Polar Mission is available, with an appropriate combination of ground based and in situ measurements. It should be noted that funding under this RTOP provides support for the operation of the observatory only; analysis of research results is funded by the interested program office. In addition, when suitable bright comets appear radio observations will be made at existing national facilities, and other visible wavelength observations will be carried out at other suitable facilities. The observatory site in central New Mexico is one of the darkest sites left in the continental U.S. Extensive photography of comets Kohoutek, Kobayashi-Berger-Milon and West has been carried out. These photographs show extensive features in the plasma tail 0.1 au. from the head which have been analyzed for phase speed and estimates of the tail magnetic field. We convincingly associated a structure in comet Kohoutek on January 20, 1974, with a specific excursion in the polar solar wind speed; this is a first. In addition, disconnection events of the plasma tail have been convincingly shown to result from sector boundary crossings and magnetic reconnection.

W82-70555 **196-41-54**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED INFRARED ASTRONOMY AND LABORATORY ASTROPHYSICS
M. J. Mumma 301-344-6994
(188-41-55; 154-50-80)

The objective of the advanced infrared astronomy program is to study the molecular constituents of solar system objects (e.g. planetary atmospheres and comets) through observations of their IR line spectra, and so to further our knowledge about: (1) molecular abundances, (2) kinetic, vibrational, and rotational temperature distributions, (3) kinetic velocity shifts (winds), (4) vertical and spatial distributions, and (5) ambient gas densities, and to carry out comparative studies of these objects. The physical information we seek is contained in the intensity profiles of isolated spectral lines and can be obtained by inversion of the observed line shapes. The measurement of spectral line shapes has recently become a tractable problem at IR wavelengths, and line shapes can now be measured by infrared heterodyne spectroscopy. The approach is to develop and employ coherent detection line receivers for use in the infrared wavelength regions. The infrared optics incorporate either gas lasers or semiconductor diode lasers as local oscillators and HgCdTe photomixers. The intermediate frequency signal is fed into a Goddard Space Flight Center standard spectral line receiver which analyzes, displays, and outputs the spectral lines. Initial observations with this system have been from the ground, but it has been developed with an eye toward flights on the NASAC-141 and in space. Laboratory work on precise line frequency determinations and on pressure broadening effects is also carried out in support of the field experiment (see also RTOP 188-41-55 and 154-50-80).

W82-70556 **196-41-67**
Ames Research Center, Moffett Field, Calif.
PLANETARY ASTRONOMY AND SUPPORTING LABORATORY RESEARCH
R. W. Boese 415-965-5501

The composition of planetary atmospheres and surfaces and the abundance, temperature and pressure of certain atmospheric constituents can be determined by spectroscopic observations from ground based and from airborne observations. Such data are necessary for the preparation of valid model atmospheres, which are needed to evaluate the possibilities of life on the planets and to design systems for exploratory missions and for the preparation of evolutionary models of planetary interiors. The objectives of this work are to: obtain, study, and analyze spectroscopic observations of the planets and their satellites; obtain and analyze, in the laboratory, spectra appropriate for valid interpretation of planetary observations; and develop the analytical and computational techniques necessary to interpret planetary spectra in terms of real planetary atmospheres and surfaces. The objectives will be pursued by measuring, in the laboratory, basic molecular parameters such as absorption line and band intensities, absorption line half widths, vibration rotation interaction constants, and line pressure induced shifts and absorption. The dependence of these parameters on pressure and temperature will be obtained by using long path gas cells, cooled and heated gas cells, and high resolution spectrometers and interferometers operating primarily in the infrared. Spectra of the planets and their satellites will be obtained by using airborne and ground based telescopes and will be analyzed to obtain information about the composition and structure of their atmosphere and the composition of their surface.

W82-70557 **196-41-68**
Ames Research Center, Moffett Field, Calif.
DETECTION OF OTHER PLANETARY SYSTEMS
D. C. Black 415-965-5495

The objective of this activity is to develop a comprehensive program to detect other planetary systems. Further objectives include the funding of selected university researchers to pursue modest exploratory development and observational programs as well as theoretical studies directed at identifying optimum techniques for ground based planetary detection systems. The choice of university researchers will be based on a peer review of unsolicited proposals, and it will be guided by the basic recommendations set forth in Volume I of NASA CP-2124. Funding will also be used to support in-house theoretical research at Ames Research Center related to the detection and study of other planetary systems.

W82-70558 **196-41-71**
Jet Propulsion Laboratory, Pasadena, Calif.
OPTICAL ASTRONOMY
Torrence V. Johnson 213-354-7427

The overall objective of the ground based optical astronomy task is the physical study of planets and their satellites, by means of ground based observations, at visible and near infrared wavelengths (approximately 0.3 to 2.0 microns). This task consists of several subtasks: (1) planetary spectroscopy, to investigate

the physical and chemical properties of the upper troposphere of Venus, Jupiter, Saturn, Uranus, and Neptune through high resolution astronomical spectroscopy and spectrophotometry; (2) Io spectroscopy &.sodium D-line patrol, to investigate the physical state and bulk motions of the neutral sodium cloud associated with Io, through a variety of advanced high resolution spectroscopic techniques, and to investigate the temporal and spatial behavior of the Na D-line emission from the Jovian satellite Io (J-1) through a synoptic program of spectroscopic observations; (3) Fabry-Perot spectroscopy, to investigate the temperature and density of low energy thermal ions in Jupiter's magnetosphere. In addition to these primary subtasks, the ground based optical astronomy task provides limited operational support (equipment maintenance and setup, observing assistance) at Table Mountain Observatory to programs supported from other sources.

W82-70559 **196-41-72**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED ASTRONOMY
Reinhard Beer 213-354-4748

The objective of this program is to understand the physical and chemical state of planetary atmospheres by means of chemical and isotopic abundance analyses as determined by spectroradiometric remote sensing methods in direct support of ongoing and planned planetary missions. The principal approach employed is that of high resolution, near infrared (1 to 6 microns) astronomical spectroscopy using a Connes'-type Fourier spectrometer at the coude focus of the 3 m IRTF on Mauna Kea, Hawaii. At the present time, the equipment is in the final stages of preparation for its removal from JPL and shipment to Hawaii. The remainder of FY-81 will be employed in acceptance testing preparatory to installation and a resumption of the observing program in FY-82.

W82-70560 **196-41-73**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO ASTRONOMY
Michael J. Klein 213-354-6160

The ground based planetary radio astronomy task will be terminated at the end of FY-81. The objective has been to conduct comprehensive studies of the atmospheres, magnetospheres, and surfaces of planets and their satellites. Radio astronomical observations, primarily at cm wavelengths, have provided input to test and refine theoretical models. Recent work includes observational studies of the atmospheres of Venus, the four major planets along with some preparatory work on comet and asteroid experiments. The microwave radiometer development effort is supportive of the radio astronomy tasks. The objectives are to design and construct state-of-the-art receiver systems for millimeter and submillimeter observations made from high altitude sites, aircraft, and eventually from space. Associated digital systems are also constructed and maintained by this task. The specific ongoing work of this task is the development of a 600 GHz heterodyne receiver. The long range goal of the submillimeter planetary spectroscopy task is to conduct comprehensive studies of the planets and satellites using the remote sensing capability afforded by coherent spectroscopic receivers operating at submillimeter wavelengths. Strong rotational transitions of many important atmospheric molecules populate this largely unexplored spectral region and the potential for planetary spectroscopy is very promising. The current objective is to develop a sound observational strategy and the necessary analytical capability to begin observations from mountain top observatories (e.g., the NASA-IRTF in Hawaii) and from aircraft as the appropriate receivers become available through the efforts of the MRD task. The objective of the missions support task is to provide specific observational results that are directly relevant to approved and ongoing planetary missions.

W82-70561 **196-41-76**
Jet Propulsion Laboratory, Pasadena, Calif.
ASTEROIDS
Dennis L. Matson 213-354-2984

This RTOP contains five tasks to further the understanding of asteroids, their origin, compositions, relations to other planets, satellites and comets, and to evaluate whether or not they pose a hazard to mankind through impacts on the Earth. The origin of asteroids and small bodies task seeks to extract the information on asteroid origin and evolution which is contained in their dynamical properties. This task also supports the determination of orbits and ephemerides for newly discovered objects and is thus, a service to the entire asteroid research community. The objectives for FY-82 are to update the study of asteroid families, continue the determination of orbits for new objects, and to start an observing program for the recovery of faint comets and asteroids. The spectral reflectances of asteroids are measured in another task. This allows the classification of asteroids by parameters which are related to composition. In the coming year photometry at wavelengths of 0.56, 1.2, 1.6, and 2.2 microns will be carried out for selected asteroids. Objects of special opportunity will be carried out for selected asteroids. Objects of special opportunity will be studied by CVF spectrophotometry and photometry at 3.5, 4.8, 10, and 21 microns. The systematic search for Earth crossing asteroids program is designed to discover new members of the Apollo, Amor and Aten asteroid groups. All of these objects must be discovered on their close approaches to the Earth. They are so small that at other times they are not locatable even with large telescopes. This effort is currently using telescopes in the United States and in Australia. The purpose of still another task is to support the organization of an asteroid research team at JPL. In addition to original research on asteroids, this team will provide scientific and technical advice to other elements of JPL and NASA in order to assist them carrying out asteroid related programs. Finally, a space-watch workshop task provides for the holding of a workshop on July 13 to 16, 1981 at Snowmass, Colorado.

W82-70562 **196-41-77**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY INFRARED IMAGING
Richard J. Terrile 213-354-6158

The object of this program is to provide high spatial resolution, ground-based infrared and visible images, and spectra of the Jupiter and Saturn systems. These data directly support instrumentation on the Voyager mission to Jupiter and Saturn and the proposed Galileo mission to Jupiter. Jupiter will be observed in the 5 micron window into the deep atmosphere as a continuation of a very successful program to monitor Jovian weather patterns throughout the Voyager post encounter period. Saturn will be observed at various infrared wavelengths in order to determine if volcanic features seen from the ground can be correlated with those observed by Voyager instruments. Ground based observations will be combined with Voyager imaging science and infrared interferometer spectrometer (IRIS) data. Imaging data collected with a CCD coronagraph at 8900 A and scan data in the infrared at 2.2 microns will allow detailed observations of Saturn's E-ring and provide ground-based information on Jupiter's newly discovered ring and satellite 1979 JI. Several comets will also be studied in the visible and infrared including a search for comet Halley and observations designed to determine the albedo and size of the nucleus. Observations will be made with existing infrared imaging systems at the Hale 5-meter telescope at 1 to 5, 8 to 14 and 20 microns and scans will be acquired at the 3-meter NASA-IRTF at Mauna Kea Observatory. The CCD images will be acquired from the Palomar 5-meter and 1.5-meter telescopes using an existing camera and data analysis facility at Caltech. A connes-type Fourier spectra is also expected to be operational at Mauna Kea Observatory and will be used to provide high spectral and moderate spatial resolution data of Jupiter, Saturn, and Titan in the infrared. Simultaneous infrared imaging will also be attempted during spectroscopy runs.

W82-70563 **196-41-79**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECKLE IMAGING OF PLANETS AND SATELLITES
Jerome Apt 213-354-2296

The technique of speckle imaging is used to reconstruct nearly diffraction-limited images of solar system objects using large ground based telescopes. The principal objectives are: (1) intensive study of Uranus and Neptune, including determination of limb darkening, radius, rotation period, and atmospheric motion; and (2) long-term monitoring of selected areas on Jupiter,

Io and Mars. Secondary objectives are investigations of the feasibility of imaging large asteroids and the hemisphere of Mercury unseen by Mariner 10. During the May, 1981 observing session images at several visible wavelengths of Uranus, Neptune, Io, and selected areas on Jupiter will be made along with an attempt to acquire data on Mercury and Vesta. During FY-82 investigators will reduce these data. Current test data indicates that the following number of resolution elements will be obtained across the diameter of these objects: Uranus 46, Neptune 26, Io 21, and Jupiter 440. If Mercury and Vesta, are feasible, the maximum number of resolution elements will be 92 and 8, respectively. Center-to-limb intensity profiles will be constructed at several wavelengths for Uranus and Neptune. These will be compared with predictions from new atmospheric models to set limits on the upper atmospheric haze structure. Spatially varying albedo features on Uranus and Neptune were briefly glimpsed under extraordinary seeing conditions; investigators expect to use these to determine the rotation periods for these planets (the present uncertainty in the periods is a factor of 2). The determined periods will be combined with existing J2 values to select among the composition models of Podolak and others. Investigators will examine the extent of any latitudinal dependence of the rotation rates of Uranus and Neptune. Investigators will begin the application of speckle imaging to long time-based monitoring by reconstructing images of the brown barges, white ovals, and small anticyclonic ovals observed on Jupiter by Voyager.

Life Sciences SR&T

W82-70564 **199-10-10**
Lyndon B. Johnson Space Center, Houston, Tex.
OPERATIONAL LABORATORY SUPPORT
W. H. Shumate 713-483-4461

The objective of the Operational Laboratories Support RTOP is to provide medical operations support by the Johnson Space Center (JSC) to approved Agency programs. The medical operations support provided under this RTOP includes studies to investigate countermeasures to physiological changes which occur when man is exposed to the spaceflight environment; clinical laboratory support of astronaut health programs; pre- and postflight testing of astronautics; and, operational tests and studies of the spacecraft environment, life support equipment, habitability systems, medical procedures, and support equipment. The approach utilized to accomplish this objective is to maintain discipline-oriented laboratories in each of the physiological problem areas covered by the Life Sciences SR&T RTOP program. This RTOP provides the funds for laboratory staff, equipment, supplies, and data management support to accomplish the operational medicine goals and objectives of the agency.

W82-70565 **199-10-20**
Lyndon B. Johnson Space Center, Houston, Tex.
MEDICAL OPERATIONS LONGITUDINAL STUDIES
Stuart Bergman 713-483-4461

The objective of the research covered by this RTOP is to conduct longitudinal retrospective and prospective studies of the medical data on the U.S. Astronauts, some of whom have flown in space, and a control group of JSC Civil Servants matched 4:1 on the basis of age, sex, race, and education. The studies covered involve individuals in a closed population in an attempt to relate changes in physiology and/or pathology to specific factors associated with individual traits of the astronauts and occupational exposure. Areas of study and of particular interest consist of acute responses and long term adaptative mechanisms to weightlessness, variations in demonstrated performance during structured, complex psychomotor tasks, and, finally, the effects, if any, of the occupational exposures to health outcome, including physiological alterations, aging, and disease/disorder incidence.

W82-70566 **199-10-30**
Lyndon B. Johnson Space Center, Houston, Tex.
CREW HEALTH MAINTENANCE
C. L. Fischer 713-483-4731

Maintenance of space crew health is a primary objective of the manned spaceflight program. This RTOP is designed to provide guidance, procedures, and equipment to achieve this objective, both now and in the distant future. Furthermore, a strict modular approach will be followed, thereby assuring a timely growth pattern for hardware development and diminishing the tendency toward sudden absolescence of an entire system because of one subunit's inadequacy. The concept of health maintenance can be dissected in the following way: disease prevention, disease diagnosis, and disease treatment. The tasks contained within this RTOP are directed toward one or more of these concepts.

W82-70567 **199-10-41**
Lyndon B. Johnson Space Center, Houston, Tex.
SYSTEMS HABITABILITY VERIFICATION
James M. Waligora 713-483-5457

A large portion of biomedical research conducted as part of the space program has to do with the effect of space specific environments on man and other organisms. What may be less obvious as a potential problem is that the environment that man is exposed to in space is almost entirely a man-made environment. Many environmental factors that are relatively constant in the Earth's atmosphere, such as O2 and CO2 concentration and pressure, must be carefully controlled by environmental control systems in the space vehicle. Acceptable control ranges and emergency ranges for environmental factors must be specified and it must be verified that the spacecraft can maintain the environment within these specifications. The specifications must provide for the safety and well-being of the crew and must also provide an environment stable enough to allow biomedical study of the space-unique environmental factors. In arriving at specifications for these environmental factors, considerations must be given to the difficulty involved in controlling a given environmental factor within a given control range and the implications in terms of cost, weight, and reliability. Defining these limits and verification that the limits are met in the spacecraft will require research in several specific areas.

W82-70568 **199-20-10**
Jet Propulsion Laboratory, Pasadena, Calif.
CARDIOVASCULAR RESEARCH
Robert Selzer 213-354-5754

On-going and past studies of the human cardiovascular response to space flight have been directed primarily at individuals who were assumed normal or disease-free while relatively little attention has been paid to the potential space flight consequences of asymptomatic or early arterosclerosis which is common to Americans in middle age. The objectives of this study are: (1) to develop improved methods to detect latent cardiovascular disease in prospective space flight pilots or passengers; (2) to study the physiological effects of space flight stress in individuals with early diffuse nonobstructive arterosclerosis; and (3) to develop advanced methods of extracting physiological features from ultrasound images of the heart and arteries and to improve resolution and gray scale. In the study of methods for detection of latent coronary disease three approaches have been taken. These are: (1) direct visualization of the coronary arteries from computer-enhanced intravenous angiograms; (2) detection of ventricular abnormality by calculation of ventricular force and impulse from ventricularograms; and (3) detection of ventricular contraction abnormality by ultrasound image processing. In order to study the hemodynamic effects of space flight stress in individuals with early nonobstructive arterial disease a theoretical and experimental method for blood flow analysis has been developed that includes animal studies, radiographic analysis, bench flow testing of arterial replicate casts and computer simulation. The JPL Medical Image Analysis Facility is partially supported from this RTOP. In the ultrasound studies both 2D and 3D near real-time feature extraction methods are under examination including boundary delineation, segmental wall motion and thickness measurements and advanced transducer concepts.

W82-70569 **199-20-11**
Lyndon B. Johnson Space Center, Houston, Tex.
CARDIOVASCULAR DECONDITIONING (JSC)
M. W. Bungo 713-483-5457

The overall goal of this program is an understanding of the cardiovascular changes (termed 'Cardiovascular Deconditioning') which occur with space flight and their impact on crew members. Specific aims are to: (1) define the underlying mechanisms of cardiovascular deconditioning; (2) provide appropriate countermeasures for these effects; (3) develop systems to aid in the accomplishment of these goals; and (4) apply the results of the preceding in an operational sense for selection, retention, and health maintenance of future space travellers. Ground based studies on both human and animal subjects will in part utilize: (1) provocative techniques such as exercise testing and lower body negative pressure, (2) bedrest studies as an analogus condition to weightlessness, (3) noninvasive and invasive cardiovascular monitoring, and (4) pharmacologic interventions, all in an effort to accomplish the goals set forth above. Direct inflight applications or continued research will be the continuum. Impact will be greater access to the space environment for more diverse segments of the population under a greater variety of conditions.

W82-70570 **199-20-12**
Ames Research Center, Moffett Field, Calif.
CARDIOVASCULAR DECONDITIONING
H. Sandler 415-965-5745
(199-20-11; 199-20-13; 199-20-14)

The overall goal of this program is an understanding of the cardiovascular changes that regularly occur with space flight and their impact for future space flight. Specific aims are to: (1) define the underlying mechanisms of cardiovascular deconditioning; (2) determine whether specific cardiovascular risks occur with short and long term weightlessness exposure; (3) provide appropriate countermeasures for susceptible individuals; and, (4) provide the background for development and implementation of space flight experiments. To accomplish these goals, ground-based studies on both human and animal subjects will be carried out. Specific activities will include: (1) immobilization (body casting) in animal models; (2) determination of the effects of exercise training; (3) the use of provocative orthostatic stress tests such as centrifugation, change in body position (tilt) and water immersion; and (4) tests of procedures, devices and drugs to prevent and counteract deconditioning. Results should lead to: (1) a better understanding of the mechanisms of cardiovascular deconditioning; (2) better devices and procedures for modifying deconditioning effects; (3) specific space flight experiments as an understanding of the risks attendant with space flight. Impact will be greatly improved flight safety, access of a broader segment of the population to space flight, and use of the weightless environment to expand our understanding of cardiovascular function.

W82-70571 **199-20-21**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE MOTION SICKNESS
J. L. Homick 713-483-5457

Manned space flight has demonstrated that space motion sickness can be unpredictable and variable among individuals. A significant observation is that in individuals who do experience this problem, symptoms can persist through the first several days of flight. Thus, on short duration shuttle flights, a major portion of mission time could be spent with some crewmembers who are not operating at a maximum efficiency. The research program outlined is directed specifically toward resolving the problem of space motion sickness. An integrated program of basic and applied research will be conducted with four major objectives or end-products in view. These are: (1) a complete understanding of the causes of this syndrome in 0-g; (2) criteria for accurately identifying, prior to space flight, individuals susceptible to space sickness; (3) satisfactory methods for the prevention of symptoms; and (4) effective methods for the treatment of symptoms when they occur. The overall objective of this research program is to produce the information required to solve the problems of space motion sickness and neurosensory adaptation to the weightless spaceflight environment. A broad based program of interrelated studies will be undertaken to delineate the etiology of the space motion sickness syndrome and to develop effective measures for its prediction, prevention, and treatment.

W82-70572 **199-20-22**
Ames Research Center, Moffett Field, Calif.
SPACE MOTION SICKNESS
N. G. Daunton 415-965-6245
(190-20-21)

Space motion sickness has been shown to be a serious problem in manned space flight if astronauts are required to move around and perform complex tasks during the first 3-5 days in 0-g. During the time that symptoms are experienced, astronauts do not operate at optimal efficiency. The objective of this RTOP is to determine the cause(s) of space sickness and to develop measures for its prediction, prevention, and treatment. To accomplish these objectives, a broad based program of interrelated psychophysical, neurophysiological, biochemical, and neuroanatomical studies on human and animal subjects will be undertaken. These studies will be directed primarily toward determining the role of vestibular, visual, and proprioceptive systems and their interactions in the development of motion and space sickness and in the maintenance of orientation and postural control in abnormal motion environments. The symptomatology of motion and space sickness will be studied, and the effects of the adaptation process and of various pharmaceutical agents on this symptomatology will be determined. Hypotheses about the etiology of, and possible countermeasures for, space sickness will be developed from ground-based research. Flight experiments will be used to test hypotheses and validate suggested countermeasures.

W82-70573 **199-20-31**
Lyndon B. Johnson Space Center, Houston, Tex.
SKELETAL CHANGES
S. I. Altchuler 713-483-4086
(199-20-91; 199-20-41)

Changes in calcium metabolism and losses of bone mineral have been observed in crewmen exposed to weightless space flight. The basis and underlying mechanisms of the changes are not known, nor are the consequences of the alterations for crewmen in long duration missions understood. The goals of this RTOP are to provide ground-based research into the mechanisms of the laterations, assessment of the changes in ground-based model systems, development of the methods to assess the changes more accurately by noninvasive methods, and then to coordinate these results into the development of countermeasures for the deleterious skeletal changes to be used by crewmen. The approach used will be to conduct clinical studies and studies in model systems to determine the precise nature of the changes and the underlying alterations producing these changes. Biochemical, endocrinologic, and physical alterations will be studied. Correlations will be performed between hormonal and nutritional alterations, and the measured changes in skeletal status and calcium metabolism.

W82-70574 **199-20-32**
Ames Research Center, Moffett Field, Calif.
BONE ALTERATIONS
D. R. Young 415-965-5549
(199-20-31; 199-20-34)

Losses of bone mineral have been observed in crew members exposed to weightless space flight. The basis and the underlying mechanisms of the alteration is not known and the consequences for passengers and crew members in future long duration space flight have not been assessed. The goals of this RTOP are to clarify the mechanisms producing skeletal alterations in hypodynamic environments, to determine the remedial measures for the prevention of alterations, to develop noninvasive measures of skeletal status, and assist in the development of operational guidelines for crew safety. Solution of the problem of bone alterations will be based upon identification of the physiological mechanisms and determination of the extent and manner in which those changes are reversible. Animal models will be studied

for an in-depth analysis of bone mass loss in ground-based simulations of hypogravic environments. The studies will emphasize investigations of mechanisms of bone formation rate, bone resorption rate, and related metabolic events as influenced by the acceleration environment. Noninvasive measures of skeletal status will be developed. Preventative countermeasures will be investigated.

W82-70575 **199-20-34**
Jet Propulsion Laboratory, Pasadena, Calif.
BONE LOSS TOMOGRAPHIC IMAGING
John Wojnaroski 213-354-7013

This RTOP will support the technical management of a feasibility demonstration to establish performance characteristics of the CT system described in the FY-81 RTOP. In support of the feasibility demonstration, JPL will: (1) conduct research in improving CT phantoms and materials to produce better models of the expected bone mineral changes; (2) analyze and define system component errors and develop a total system error model; (3) build a small scanner system for testing the improved phantoms and establishing the statistics for the photon flux of Gd.-153; (4) generate images of standard CT phantoms to demonstrate system of performance and verify the error model; (5) scan JPL produced phantoms and verify accuracy of these phantoms for modeling bone and tissue; and (6) maintain an awareness of emerging technologies and alternate techniques that might improve or complement the CT system.

W82-70576 **199-20-41**
Lyndon B. Johnson Space Center, Houston, Tex.
MUSCLE ALTERATIONS
N. M. Cintron 713-483-4086
(199-20-31)

The regulation of muscle integrity and function during space flight and the causes of its apparent atrophy are the central questions addressed by the present research program. It intends as its overall research goals to elucidate and define the mechanisms and biochemical factors operative in the processes associated with muscle metabolism and atrophy during weightlessness and to develop effective countermeasures to these muscle alterations in order to optimize man's performance and recovery upon return to a one-g environment. In addition, it intends to develop methodology for feasibly estmating muscle mass and its turnover in ground-based and space flight-associated studies. Using animal models, studies to define the molecular mechanisms underlying muscle mass regulation and atrophy will focus on the dynamics, enzyme systems, and effectors of protein and carbohydrate metabolism; the chemical bioenergetics, membrane dynamics, and mechanics of contractile function; and the role of motor activity, hormonal influence, and neuromuscular processes in the maintenance of muscle function. Preventive countermeasures directed at the major muscle control sites will be evaluated; included among these are increasing contractile function, stabilizing protein balance, and maintaining appropriate energy levels via nutritional and chemical manipulations. Finally, techniques for monitoring muscle mass will focus on the analysis of muscle-specific metabolites and enzymes and will involve varying biochemical/physiological approaches.

W82-70577 **199-20-42**
Ames Research Center, Moffett Field, Calif.
MUSCLE ATROPHY
S. Ellis 415-965-5757
(199-20-41)

The overall aims of this research program are to determine the underlying causes for the muscle atrophy problem observed in both humans and animals in space and to develop suitable measures to counter these undesirable changes. Specific objectives consist of: (1) conducting basic studies into the nature of the biochemical and physiological mechanisms which regulate skeletal muscle mass and properties; (2) developing and validating methods for monitoring the rate of atrophy of skeletal muscle in human subjects and laboratory animals; and (3) investigating possible countermeasures which may forestall muscle atrophy induced by disuse and weightlessness. Muscle atrophy will be achieved in experimental animals principally by immobilization with casts and by suspension hypokinesia. In special circumstances denervation, tenotomy, and castration will be used to produce atrophy in specific muscles or to evaluate the effects of innervation. Since the degree of active or passive tension of a muscle has been shown to play an important role in the development of atrophy, this factor will also be examined and controlled in the above models. In pursuit of an understanding of the mechanism by which muscle atrophy develops, the parameters to be studied are principally biochemical and histochemical.

W82-70578 **199-20-51**
Lyndon B. Johnson Space Center, Houston, Tex.
BLOOD ALTERATIONS (INFLUENCE OF SPACE FLIGHT ON THE BLOOD AND BLOOD-FORMING TISSUES)
G. R. Taylor 713-483-4086
(199-20-60)

The most significant effects of the space flight environment on the blood and blood-forming tissues in man have been a reduction in the blastogenic transformability of lymphocytes, and a consistent reduction in the circulating red blood cell mass. The variations in the magnitude of the loss in individual crewmen and the complicated postflight recovery kinetics suggest a complex relationship between the red cell mass loss and the duration of the exposure to weightlessness. This 'anemia of space flight' was frequently accompanied by a reduction in plasma volume, apparently occurring early in the mission and sustained throughout the flight. Other, more subtle, effects have been observed with respect to the function and structure of red blood cells and of lymphocytes, and in the concentration of some plasma proteins. This research program seeks to determine the significance of these reported changes and to determine their medical significance, if any.

W82-70579 **199-20-52**
Ames Research Center, Moffett Field, Calif.
BLOOD ALTERATIONS
H. A. Leon 415-965-5359
(199-20-51; 199-20-54)

A decrease in the red blood cell (RBC) mass has been a common finding in human space flights. Recent U.S. and U.S.S.R. flights show that this loss can occur in the absence of hyperoxia. While it is likely that the decrease is due in part to a decreased production, evidence suggests that weightlessness can induce hemolysis in rats. Also, the RBC membrane changes noted in Skylab suggest that hemolysis may occur in astronauts also since membrane alterations are often a prerequisite for sequestration and hemolysis. The significance of these studies is that hemolysis in weightlessness appears to be an early occurrence. This could become a significant factor for short flights particularly with nonastronaut participants. The major objective of these studies is to elucidate these hemolytic mechanisms. These studies will contribute to an understanding of pathological hemolytic disorders. Mammals exposed to high altitude develop an increased RBC mass. Rats, experience a transient but significant hemolysis upon return to sea level air. It is felt that this is a convenient and realistic model for at least a portion of the mechanisms which cause hemolysis in weightlessness. Also, the RBC membrane will be specifically studied in certain well defined experimental systems.

W82-70580 **199-20-54**
Jet Propulsion Laboratory, Pasadena, Calif.
BLOOD ALTERATIONS
K. R. Castleman 213-354-5660

The study of spaceflight induced blood alterations requires accurate and quantitative morphological analysis of both red and white blood cells. JPL, NASA-JSC and NASA-ARC all have ongoing developmental efforts in quantitative digital image analysis of microscopic biological specimens. The three groups utilize similar equipment and face similar problems regarding computer development, instrument calibration, and data storage formats. This task implements an active collaboration effort to coordinate the hardware and software development and prevent duplication of effort. The availability of high quality solid state image sensors and powerful microprocessor chips makes it possible to implement complex image analysis algorithms that operate in real time or

near real time. In the future more Earth-based and space-based NASA life sciences research will require high speed quantitative analysis of microscopic specimens. This RTOP will foster the development of high performance image analysis hardware and software to support this upcoming research. In the past three years this RTOP has supported the development of microscopic image processing hardware and software at the three centers, and it has fostered a sharing of the technology between the centers to the extent that all three now have similar systems and capabilities.

W82-70581 **199-20-61**
Lyndon B. Johnson Space Center, Houston, Tex.
FLUID AND ELECTROLYTE CHANGE
Carolyn S. Leach 713-483-4086
(199-20-11; 199-20-31; 199-20-51)

Body fluid compartment shifts occur in early exposure to weightlessness. These changes are complicated by losses in electrolytes (sodium, potassium, calcium, phosphorus, magnesium and chloride) occurring at a slower rate over mission duration which further influence fluid distribution. Hormonal responses are elicited to counteract these changes. The purpose of this program will be to study these changes and their effect on man's (astronaut and non-astronaut) ability to function in space. Results of the investigations in this RTOP will provide an understanding of the physiological and biochemical effects of weightlessness and rationale for nutritional and/or other countermeasures for use in future space flight missions. The information gained from exposure of man to weightless flight for periods approaching three months has shown that fluid and electrolyte metabolism has been altered in all crewmen studied. It is apparent that the changes experienced are multiphasic and are caused not only by the weightlessness environment but also by conditions related to the preparation for flight, the activity during flight, and the recovery procedures. The overall objective of this research program is the elucidation and definition of biochemical agents and physical factors operative in the processes associated with fluid and electrolyte metabolism in the space flight environment.

W82-70582 **199-20-62**
Ames Research Center, Moffett Field, Calif.
FLUID AND ELECTROLYTE CHANGES
L. C. Keil 415-965-6378
(199-20-61)

Headward fluid shifts accompanied by loss of plasma volume and electrolytes are some of the most prominent changes that occur during weightlessness. These changes not only produce symptomatic discomfort (nasal congestion and head fullness), but the increasing loss of sodium and potassium and loss of plasma volume compromises the cardiovascular response to reentry G forces. Changes in the blood levels of fluid/electrolyte hormones are observed; however, the electrolyte-retaining hormones are unable to prevent the sodium/potassium loss. Although no in-flight data were obtained from flights lasting as long as six months, the post-flight data indicates that irregularities in fluid/electrolyte homeostasis still persist in spite of increased in-flight intake of sodium and potassium. The primary objective of this RTOP is to investigate and characterize the physiological mechanism(s) responsible for these in-flight changes in fluid/electrolyte metabolism. Once the mechanism is known appropriate administration of dietary or hormonal agents during flight may be used to restore or prevent excessive fluid/electrolyte loss. In order to investigate the fluid/electrolyte mechanism affected by headward fluid shifts, data will be obtained from horizontal and head-down bed rest studies. These data will be analyzed and compared to that generated in animals subjected to similar episodes of blood redistribution in an effort to define the responsible mechanism.

W82-70583 **199-20-71**
Lyndon B. Johnson Space Center, Houston, Tex.
RADIATION EFFECTS AND PROTECTION
C. M. Barnes 713-483-5281

This RTOP describes a long term program of research on the effects of the space ionizing radiation environment and its consequences for manned space operations. While currently available information is sufficient for early shuttle missions, research priorities of the attached program are based on the assumption that NASA's long term plans will involve man in geostationary orbit before the year 2000. Based on knowledge obtained from previous research under this RTOP, exposure to ionizing radiation may be the limiting factor in both mission duration and total career for the crew. Furthermore, shielding considerations, especially for protection from solar particle events, may influence significantly the detailed design and total mass of a spacecraft. A plan is presented for research in specific areas of radiobiology and radiation dosimetry. Specific attention is given to the effects of HZE particles of space since the problem is unique to NASA.

W82-70584 **199-20-72**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL EFFECTS OF PARTICLE RADIATION
D. E. Philpott 415-965-5218
(199-20-71; 199-20-76)

This program is designed to: quantify various long term biological effects of radiation as encountered in space as a function of dose equivalence; develop morphological, physiological, and biochemical techniques for quantitative evaluation of changes in the rate of aging induced by exposure to particle radiation; establish baseline data on the aging process of brain, retina and other organs of mice maintained under normal laboratory conditions for comparison with the results obtained on particle irradiated animals; and determine acute and chronic morphological, morphometric, and enzymatic changes in the mammalian brain following both particle and photon irradiation. Experimental animals will be exposed to HZE particles at the Lawrence Berkeley Laboratory. Damage of the retina, brain, and other organs at varying intervals after irradiation will be determined by pathological, morphological, biochemical, and physiological methods. The rate of aging in brain, retina, or other selected tissues will be investigated by the use of electron microscopy and cytochemical techniques.

W82-70585 **199-20-74**
Jet Propulsion Laboratory, Pasadena, Calif.
ULTRASENSITIVE MASS SPECTROMETRIC MEASUREMENT OF RADIATION-DAMAGED DNA
R. Hammen 213-354-4857

The overall objective of this research program is to develop methods for directly measuring on humans the damage induced in DNA by radiation exposure during space operations. It is well known that high energy radiation and ionizing particle bombardment can initiate malignant tumors in man and animals. It is also widely accepted that the key initiation step involves damage to DNA which, if not repaired correctly, causes heritable genetic alterations in later generations of cells. Since the induction period for tumors resulting from radiation exposure may be twenty years, it would be desirable to know beforehand the extent of DNA damage incurred by humans in space and to be able to follow the responses of the astronaut's DNA repair systems to these lesions. Requisites to such an analysis are selectivity of detection of a DNA lesion, small sample sizes (punch biopsy), and extreme sensitivity. The Electro-Optical Ion Detector (EOID) mass spectrometer developed at JPL is the only instrument in existence that satisfies these criteria. The objective of the first year's research is to develop methods for detecting and quantitating radiation damaged DNA, using the EOID mass spectrometer. Mammalian cells will be exposed to a radiation source (UV, 60 sub Co-gamma) and the DNA will be isolated from the cells by conventional techniques. The polymer DNA will be applied to the pyrolysis mass spectrometer side which *thermolytically cleaves the glycosidic bonds and liberates the* aromatic bases into the mass spectrometer. Subtraction of the mass spectrum of a sample of unirradiated DNA will reveal ion fragments diagnostic of the radiation induced lesions. By the use of internal standard techniques calibrated with samples of DNA with known quantities of radiation altered bases, the data system of the mass spectrometer will be programmed to read out the fraction of total DNA bases that have been chemically altered by the type of radiation in question.

W82-70586 **199-20-76**
Langley Research Center, Hampton, Va.
RADIATION EFFECTS AND PROTECTION
P. F. Hollway 804-827-2893

Radiation protection data and analytical methods will be developed for use in assessing optimum dosimetry requirements, human performance factors, impact on mission objectives, and anticipated exposures in various body tissues as input to radiobiological studies (especially in connection with high energy heavy ions). Particular attention will be given to calculating buildup factors for protons, developing multilayered electron shielding methods, furthering the heavy ion transport theory, evaluating basic environmental data for human protection problems, evaluating self-shielding factors, and analyzing protection requirements in Earth orbit as input to mission planning exercises. The Langley Research Center will maintain a basic research effort in this area. Both the needed expertise and computer facilities required are available at LaRC. New analytical methods will be developed for radiation transport which are amenable to mission analysis, and for use in shield optimization procedures. Theoretical models of the nuclear reaction of heavy ions are being developed, and complementary experiments are being performed in cooperation with the DOE. Extensive reviews and evaluations of existing reaction data and theoretical models will be made for the generation of libraries of evaluated data and calculational techniques. The development of the necessary reaction data base and calculational models must precede the application to specific NASA programs.

W82-70587 **199-20-82**
Ames Research Center, Moffett Field, Calif.
HUMAN BEHAVIOR AND PERFORMANCE
R. M. Patton 415-965-6602

Manned space missions require high levels of human performance in unfamiliar and stressful environments. Future missions will involve crewmembers, scientist passengers (chosen for their scientific and technical expertise, and not trained as career astronauts) and ultimately people from the population at large. Because of the high cost of these missions, and the high value of their successful completion, every effort must be made to maximize the probability of successful performance and adjustment to mission conditions by all crewmembers and passengers. Selection, training, and performance monitoring procedures that are appropriate to crews involved in manned space missions will be developed. Task oriented groups will be analyzed in order to specify the best structure and composition of groups engaged in manned space missions. The human response to the stresses of spaceflight will be examined in order to develop procedures to prevent performance decrements and to remedy those that do occur. Both laboratory studies and studies of real world situations (such as supertanker crews and crews of oceanographic research vessels) will be undertaken to identify the personal, group, procedural and situational characteristics predictive of effective or ineffective performance, and to develop preventive and remedial measures that may be employed in order to counter possible performance decrements.

W82-70588 **199-20-91**
Lyndon B. Johnson Space Center, Houston, Tex.
GENERAL BIOMEDICAL RESEARCH
W. H. Shumate 713-483-4461

The objective of the general biomedical research RTOP is to provide scientific studies in support of Agency goals. These studies will include those not specifically related to one of the problem oriented RTOP's or general studies which support more than one of the problem oriented RTOP's. Areas presently being studied under this RTOP include: investigations to enable the detection of diseases in the prodromal stage; a quantitative analysis of factors associated with decompression sickness; and, the mathematical modeling of various body systems including calcium, erythropiessis fluid and electrolytes and cardiovascular.

W82-70589 **199-20-92**
Ames Research Center, Moffett Field, Calif.
GENERAL BIOMEDICAL RESEARCH
A. D. Mandel 415-965-5061
(199-20-91)

The overall objectives of this research program are to consider any problem areas that are not being addressed in any of the current major problem oriented RTOP's. Also, any future problems, not now identified and which may develop as a result of on going Cosmos, Salyut, and shuttle programs, and not applicable to any other RTOP will be included in this RTOP. Specific objectives consist of studies of: (1) fatigue; (2) circadian asynchrony; (3) suboptimal work capacity; (4) poor food acceptance; (5) early diagnosis of infectious disease; (6) predictability of immune responsiveness. This program will examine the ability of certain blood components to respond to an infectious agent, and to use this information to determine whether or not an individual is in the prodromyl stage of an infectious disease. In addition, studies will be done in order to determine whether the presence of certain serum components can predict the ability of an individual to respond favorably to an infection at a future date. Studies will continue on the mechanism of regulation and control of neurotransmitters, especially the role of dietary factors. Factors which are concerned with the regulation of carbohydrate metabolism, especially high glucose and saturated fat diets will continue. The control of body temperature regulation by the central nervous system will be extended by studies to determine active central nervous system sites during pyrogen induced fever.

W82-70590 **199-40-20**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENTAL BIOLOGY - RESPONSE OF REPRODUCTIVE PROCESSES IN HIGHER PLANTS SUBJECTED TO SPACE ENVIRONMENTS AND GRAVITY EFFECTS MODIFIED BY A CLINOSTAT
Takashi Hoshizaki 213-354-3374

The objectives of this RTOP are to determine and characterize the asexual and sexual reproduction processes of higher plants under weightlessness and modified gravity environments to gain new insight on gravity's role in the initiation and development of the plant root, flower, fruit, and seed. Information on the mechanisms of hormonal action and mineral interaction in these processes will be sought. A better understanding of gravity's role in plant growth and development would allow enhancement of plant productivity through specific metabolic controls and biochemical modifications. For the sexual reproduction study, the approach is to use whole plants and excised organs. One of the candidate species for study is Capsella bursa-pastoralis, a species that is a classic example used for embryo development. The development of floral and embryo structures will be studied in Earth gravity modified by a clinostat and under weightlessness in space. For the asexual reproduction study, explants will be used. Coleus is one of the candidate species. The interaction of hormones and weightlessness on root formation and development will be studied. Modified gravity experiments using clinostats will be included. Polarity and concentration gradients of hormones will be determined in stem explants exposed to different gravity environments. Determiners for polarity and concentration gradients in addition to physiological or chemical markers such as calcium will be sought.

W82-70591 **199-40-22**
Ames Research Center, Moffett Field, Calif.
DEVELOPMENTAL BIOLOGY
H. P. Klein 514-965-5094

This RTOP is concerned with the investigation of the role of gravity and space radiation on the mechanisms of development, maturation, senescence, and evolution. Research will be performed to determine the effects of space radiation and gravity, from high G loads to near-weightlessness, on: the maintenance of cellular integrity and cellular relationships; the biochemical and biophysical reactions that control cellular division and differentiation; and on the growth and development of organisms. In addition, the last stage of the life cycle of organisms, namely the aging process, will be also examined. Animals will be maintained in

space during a complete life cycle and will be brought back to Earth in order to study their adaptation to normal gravity. Moreover, research on animals exposed to hypergravity in ground based facilities will identify gravity-dependent and gravity independent systems. Previous research based on chronic centrifugation and on exposure to space weightlessness onboard USSR Cosmos biosatellites suggests that the effects of various G levels on development and aging are intertwined with changes in metabolic rate. Therefore, considerable attention will be paid to the effects of hypergravity and space weightlessness on cell and organismic respiration, mitochondrial biochemistry and lipid peroxidation processes associated with energy production.

W82-70592 **199-40-30**
Jet Propulsion Laboratory, Pasadena, Calif.
BIOLOGICAL ADAPTATION - STUDIES ON EFFECT OF WEIGHTLESSNESS ON PHYSIOLOGICAL RESPONSES OF HIGHER PLANTS TO NUTRITIONAL AND ENVIRONMENTAL FACTORS
Takashi Hoshizaki 213-354-3374

The overall objective of this RTOP is to characterize the effect of gravity on the biological adaptation of higher plants. The effort proposed in this RTOP will specifically focus on the physiological mechanisms of selected plants to reduced gravity in the areas of nutrition, light, and mechanical stress. Nutritional studies will be conducted to determine the possible differences in gravitational responses of three types of nutrients: (1) elements which have only been shown to function in structure (e.g., silicon in rice); (2) those elements which are metabolically active but have not been shown to be directly involved in structure (e.g., iron in corn and rice); and (3) elements which have been shown to directly affect structure and are metabolically active (e.g., calcium in corn and rice). Studies will include the gravity effect on translocation, distribution, site of deposition, and metabolic functions in the structure and reproduction of selected plants. Studies on interaction of light and gravity will be limited to the flowering response of photoperiodic sensitive short-day plants. A change in the gravitational environment induced by a clinostat has shown that an increase in the dark period is necessary to initiate flowering. To determine the mechanism causing this increased dark requirement, vibrational, and mechanical stresses produced by the clinostat as well as possible change in physiological processes within the plant will be studied. In the area of mechanical stress, studies will be conducted to determine the effect of the launch environment (vibration) on possible results of experiments to be performed in weightlessness. The studies will focus on the effect mechanical stress on the quality and quantity of lignin and cellulose deposited in the stem of higher plants. The observed lignin and cellulose content will be correlated with the applied vibration environment as a function of amplitude, frequency and duration.

W82-70593 **199-40-32**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL ADAPTATION
E. M. Holton 415-965-5471
(199-40-10; 199-40-20)

The overall aims of this RTOP are to increase understanding of biological processes as they are affected by the unique environment of space, to identify and assess the biological mechanism by which living systems respond and adapt to space flight environmental parameters (particularly altered gravity) as well as the interactive affects of gravity and other stimuli and stresses on the physiology and metabolism of organisms, and to determine functional variations and regulating mechanisms at all levels of biologic organization in animal systems using gravity as a tool to yield new understanding about living systems on Earth. Biochemical, physiological, and anatomical changes in organisms exposed to altered gravity will be delineated and quantified. Altered gravity states will be introduced by means of simulated weightlessness (Holton model and modifications) or acceleration (centrifuge). Morphologic changes, modified biochemical pathways, and changes in specific physiological functions will be assessed in terms of exposure intensity and duration. A significant part of this effort will elaborate on the regulatory factors in homeostatic adaptation to and deconditioning from the metabolic stress associated with a change in the gravity field.

W82-70594 **199-50-12**
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION
H. P. Klein 415-965-5094
(199-50-32; 199-50-42)

The objective of this RTOP is to study the origins and chemical evolutionary pathways of organic matter in the cosmos which led, in the case of the Earth, to the emergence of life but which, in extraterrestrial environments, may have taken divergent paths. Chemical evolution research encompasses the study of the evolutionary path of carbon and its compounds from the primal fireball, through interstellar clouds, to formation of solar systems, to the beginnings of life on Earth. In experiments conducted under conditions designed to simulate the putative environments of cooling solar nebulae, cometary heads and tails, and primitive and contemporary planetary atmospheres surfaces, the extent and nature of abiotic synthesis of organic matter are determined. Natural evidence bearing on the validity and generality of the chemical evolution hypothesis is sought through organic and inorganic analyses of materials having extraterrestrial (e.g., meteorites, lunar samples, interstellar dust grains, Martian soil) and ancient and recent terrestrial origin. The intimate association of minerals with organic matter everywhere in the cosmos and their necessary cogenesis and co-evolution make it essential to understand the influences of one on the other. From comparative planetological studies and the study of the organic geochemistry, mineralogy, and petrology of natural samples will come an understanding of the factors that have influenced the course of chemical evolution on planetary bodies and the origin and early evolution of life on Earth.

W82-70595 **199-50-32**
Ames Research Center, Moffett Field, Calif.
ORIGIN AND EVOLUTION OF LIFE
H. P. Klein 415-965-5094
(199-50-12; 199-50-24)

The objectives of this RTOP are to explore the mechanisms, processes, and environments associated with the origin(s) and evolution of life on Earth and to ascertain to what extent they represent constraints within which life can develop elsewhere in the Universe. Information obtained will be used to design models lending themselves to experimental verification. The origin of life represents a point on a conceptual continuum that characterizes the physical, chemical, and biological evolution of matter. While experimental verification of hypotheses concerned with cosmological and chemical evolution can be carried out on the extraterrestrial stage, studies on the origin and evolution of life are limited to the only experimental material available, terrestrial life. Several crucial areas of study have been identified for extensive investigation from which first principles can be discerned and applied to the formulation of a theory for the origin and early evolution of life. Two approaches are adopted for studying biogenesis and bioevolution: one is to deposit plausible models for relevant processes and environments, and test them either experimentally or by the use of computer simulations; the other is to identify early events and their evolutionary context in contemporary organisms since they are, in fact, repositories of information concerning what took place during the evolution of life.

W82-70596 **199-50-42**
Ames Research Center, Moffett Field, Calif.
SOLAR SYSTEM ENVIRONMENTS
H. P. Klein 415-965-5094
(199-50-12; 199-50-22)

The objective of this RTOP is to provide specific information on the chemical composition of the atmospheres and the volatiles in surface and particulate matter of solar system bodies including planets, their satellites, comets, asteroids, meteorites and particulate matter in space. This information is essential for selecting or devising the most appropriate model for the evolution of the solar system and for each of the investigated bodies, and will further provide a basis for understanding the conditions

necessary for the origin of life by comparisons of the evolutions and the chemistries of these bodies. Improved methods and instrumentation will be developed for in situ chemical analyses of the gaseous species contained in atmospheres, surfaces and particulates. Special emphasis is directed to the development of the gas chromatographic approach since it is not proven to be among the most effective means for measuring complex gaseous chemical mixtures. Improvements in the gas chromatography, such as column technology, detector design, and total system design (including work on other subsystems), will be rigorously explored.

W82-70597 **199-50-52**
Ames Research Center, Moffett Field, Calif.
LIFE IN THE UNIVERSE
H. P. Klein 415-965-5094
(199-50-32)

The objectives of this RTOP are: to understand the history of the biogenic elements in the galaxy, particularly in interstellar clouds and stellar nebulae, and during the early evolution of the Earth; to study possible evolutionary pathways for complex life in the Universe; and particularly to examine the influence of astrophysical, stellar, and solar system events on the evolution of complex life on the Earth. A series of Science Workshops will be convened to explore the major scientific questions, to determine which are amenable to theoretical, experimental or observational approaches, and to recommend the major elements of a technical plan to pursue those objectives. The recommendations of the Science Workshops will then be incorporated into proposals for Agency program plans for the History of the Biogenic Elements and for the Evolution of Complex Life, each to be an element of the Life in the Universe program. In parallel with the Science Workshops, each area will include some preliminary tasks which will assist in the crystallization of program plans or which are cogent examples of the type of research appropriate for the two areas. As detailed program plans are defined in each area over the next two fiscal years, FY 82 and FY 83, it may be appropriate to split this RTOP into its two major components.

W82-70598 **199-50-94**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY PROTECTION PROGRAM
J. B. Barengoltz 213-354-2516

The objective of this RTOP is the development and installation of a new NASA Planetary Protection Policy and program which is appropriate to the current knowledge of the Solar System and to the current NASA mission model. Reviews of recent planetary data indicate that the existence of life forms elsewhere in the Solar System is unlikely. At the same time the planned planetary exploration program has been significantly reduced. The goal in the development of a new PP policy and program is to relax the requirements imposed on missions but to retain the prudent protection of future scientific investigations. Based on the planetary data and the mission model, the new PP program would exempt all but a few types of missions to an exceptional set of celestial bodies from requirements which force implementing procedures. Many traditional PP procedures which are expensive and antagonistic to mission science objectives and even to mission success are no longer realistic for most missions. The standard analyses historically employed to demonstrate compliance with quantitative requirements also lose meaning in the face of miniscule and somewhat arbitrary probabilities of growth and a sparse mission model. For most missions qualitative and operational procedures would be adequate and possibly even more useful. The approach of the work under this RTOP will include the drafting of a new PP policy, supporting documentation, and new implementing issuances. Consideration will also be given to missions where the PP role and requirements are unclear, such as sample return missions. Appropriate studies and analyses in support of the objectives of this RTOP will be conducted. This RTOP also provides for program planning and review, technical monitoring, reporting, solicitation and review of proposals, contracted studies, consultant services and other management functions as required.

W82-70599 **199-60-11**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED LIFE SUPPORT SYSTEMS
R. L. Sauer 713-483-2759

The objective of this RTOP is to identify the requirements and to develop the technology that will be required to provide the metabolic support systems for the next generation, long duration, manned space missions. These metabolic support systems include atmosphere revitalization and control, water reclamation and supply, hygiene and waste management, and food service and supply. This RTOP covers the research, development and testing needed to support the eventual design and fabrication of the flight metabolic support systems. This RTOP will include the effort required to support the development of the metabolic support systems for a long term orbital space vehicle, and in many instances, will culminate with the fabrication and testing of flight prototype hardware. Following system concept identification, technology gaps and needs will be identified to permit timely investigation and solution. It is to this and the accompanying development of subsystem concepts, procedures, and developmental hardware that the initial effort will be directed. This early effort will provide for alternate and potentially more efficient but less developed concepts where technical tradeoffs indicate a potential overall benefit to the program through decreased expendable, weight or volume requirements, increased reliability and maintainability, and increased crew acceptability and performance.

W82-70600 **199-60-12**
Ames Research Center, Moffett Field, Calif.
ADVANCED LIFE SUPPORT SYSTEMS
P. D. Quattrone 415-965-5733
(199-60-22; 199-60-12)

The objective of this program is to advance the technology base for regenerative life support systems required to support long-term manned space missions. The regenerative life support processes must provide a more complete system closure (reduction of expendables). The subsystem functions to be investigated and developed include the following: air revitalization; atmospheric supply and composition control; water reclamation; and waste management systems. Specific life support subsystem technology areas will be investigated (feasibility and/or development) and subsystem concept designs will be generated. This RTOP will be directed toward advancing the technology and/or hardware development status for advanced life support subsystems, and will result in achieving a technology base (research and hardware development) for subsystems that have the characteristics of low maintenance, high reliability, and long life.

W82-70601 **199-60-21**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED EXTRAVEHICULAR ACTIVITY WORK SYSTEM
M. Rodriguez 713-483-2961

The objective of this RTOP is to develop the technology necessary to remove significant limitations exhibited by the existing EVA work system and to develop a 'Next Generation' EVA work system for use in support of advanced activities such as satellite servicing or long-range missions such as the Space Operations Center or Space Construction Base. The EVA work system will provide life support, propulsive maneuvering, and universal work site interfaces and will be conceived to minimize both the use of crew overhead time for EVA preparation and the use of vehicle expendables for recharge. The initial emphasis will be on the development of a high mobility, nonventing space suit and life support system that will maximize the utility of an EVA work system for the servicing of scientific payloads. To assure that the best designs possible are promoted, prototype space suits will be provided for evaluative testing in zero-G simulation facilities (i.e., WIF, O-G, aircraft). The focus of the initial development will be to develop a design that is responsive to the near-term operational requirements for EVA servicing (i.e., Space Telescope).

W82-70602 **199-60-22**
Ames Research Center, Moffett Field, Calif.
ADVANCED EXTRAVEHICULAR SYSTEMS
P. D. Quattrone 415-965-5733
(199-60-12; 199-60-21)

The objective of this RTOP is to advance the technology base for advanced extravehicular systems required to support long-term manned space missions. The advanced extravehicular systems must provide for extended EVA capability. This RTOP program will emphasize: improved hardware performance; increased hardware and system life; and reduced EVA equipment and payload design, manufacturing, maintenance, and operations costs. The technology areas associated with protection of an EVA astronaut will be pursued under this RTOP. This includes: development of efficient high pressure (> or – 8 psig) suit components that provide for greater mobility; development of advanced liquid cooled/vent garments to provide improved thermal comfort and control; development of regenerative portable life support subsystems to eliminate or reduce the expendable requirements associated with thermal control; and development of portable life support components.

W82-70603 **199-60-42**
Ames Research Center, Moffett Field, Calif.
FOOD REQUIREMENTS, PRODUCTION, AND PROCESSING FOR CELSS
L. P. Zill 415-965-5759
(199-60-30; 199-60-50; 199-60-60)

The objective of this RTOP is to investigate various methods of utilizing processed waste materials to regenerate food in a controlled environment life support system (CELSS). Methods of food production that could be employed in controlled environments will be investigated. These include photosynthesis by organisms ranging from algae to higher plants, and physico-chemical methods, such as photo--reduction of CO2. In the latter case, reduced organics could be fed to nonphotosynthetic organisms, such as yeast and bacteria, which could be used as human food materials after appropriate processing. During the early phases of the program, investigation of higher plants will be emphasized. Research will be concentrated on plant nutrient requirements; stability and reliability of production, including toxin production and characterization; controllability of growth; and variation in food nutrient value. Plants will be selected and evaluated through growth and product analyses in a simulated CELSS environment. Plant production techniques will be identified, evaluated, and developed. Candidate plants and methods will be tested in a simulated CELSS environment in conjunction with waste management and systems management development.

W82-70604 **199-60-52**
Ames Research Center, Moffett Field, Calif.
WASTE MANAGEMENT FOR CELSS
T. Wydeven 415-965-5738
(199-60-40; 199-60-60; 199-60-30)

The objectives of this RTOP are to plan and conduct the research and develop the technology required to process wastes so as to produce materials necessary for regenerating food in a controlled ecological life support system (CELSS) for space applications. Models of the waste materials to be processed by the waste management system in a CELSS for use in space will be developed. Exploratory studies will be undertaken of each of the major waste management technologies that have been identified to date as candidates for CELSS. The candidate methods are wet oxidation, incineration, aerobic, and anaerobic biological oxidation. Emphasis in the exploratory studies will be placed on determining the adaptability of a given waste management method to producing a product that can be used subsequently to regenerate food. Inherent in this approach is investigation of methods to remove and separate organic and mineral components of the effluent.

W82-70605 **199-60-62**
Ames Research Center, Moffett Field, Calif.
SYSTEMS MANAGEMENT, CONTROL, AND ECOLOGICAL CONSIDERATIONS FOR CELSS
R. D. MacElroy 415-965-5573
(199-60-30; 199-60-50; 199-60-40)

The objectives of this RTOP are: (1) to identify and investigate biological functions in isolated autonomous controlled ecological life support systems (CELSS) that must be controlled to achieve stable system operation; (2) to identify and investigate control parameters in biological, chemical, and mechanical systems and to identify parameter coupling and develop control strategies; and (3) to establish and maintain communication and cooperation among investigators in the CELSS Program. The approach used in this RTOP is to develop theoretical and/or experimental investigations of significant problems affecting CELSS system operation, control and stability. In addition, because this work intersects other CELSS investigations in the areas of Food Production (199-60-42) and Waste Management (199-60-52), certain tasks address problems of promoting an integrated CELSS Research Program and supporting continuous communication between program investigators and program managers.

W82-70606 **199-60-71**
Lyndon B. Johnson Space Center, Houston, Tex.
MAN-MACHINE ENGINEERING REQUIREMENTS FOR DATA AND FUNCTIONAL INTERFACES
J. L. Lewis 713-483-4966

The objectives of this RTOP include: quantification of man machine engineering data, both on the ground and in flight; study of state-of-the-art technology to advance that technology for the purpose of creating more effective and efficient man machine interfaces for manned spacecraft; and development of improved techniques of man machine engineering design so that innovative steps may be taken toward creating better crew interfaces in future vehicles. A series of continuing tasks to identify and implement workable instrumentation packages for acquiring quantitative man machine engineering data in one-g, simulated zero-g, and actual zero-g will be implemented. To continue those efforts currently defined that lead toward definitive design requirements for use as inputs to the Design Performance Lab will be continued and feasibility studies of promising new crew interface items will be pursued.

W82-70607 **199-60-74**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED MAN-MACHINE STUDIES
John D. Hestenes 213-354-2961

The objective of this RTOP is to develop and validate the use of Event-Related Potential (ERP) measurements for evaluation of human cognition, performance, and behavior in space. This includes the following: (1) to establish a laboratory at JPL to study the specificity, reproducibility, and applicability of ERP measurements as a research tool in the study of man machine interactions; (2) to develop ERP measures of human operator workload and allocation of attention in a three dimensional task environment; (3) to validate the applicability and relevance of ERP measurements during human performance of various tasks similar to those found in pre-flight, in-flight and post-flight aspects of the NASA space program; (4) to test the suitability of ERP information for adaptive man machine systems; (5) to examine use of ERP information for biomedical purposes in space. A capability for measurement and analysis of ERP during operator task performance will be established at JPL in conjunction with investigators at the University of Illinois (Psychology), Caltech (Bioinformation Systems) and UCLA (Computer Science). Selected two dimensional simulation studies performed for JPL at Illinois in 1980 will first be replicated beginning in FY 81 at JPL. This will be extended to two and three dimensional studies using the JPL man machine facilities. The university collaborators will do studies to conform methods of measuring and identifying ERP events given simultaneous visual stimuli from early ERP signal information emphasizing the time sequence of the scalp distribution of ERP events. Calculations will be made of the trajectories of dipole sources within the head. A strategy will be developed for processing single epochs for real-time, adaptive

three dimensional ERP data acquisition and analysis. Specific studies will be related to man machine tasks like those expected in the NASA space program including initial design of a space flight experiment. This research represents a unique approach to real-time examination and quantification of human cognitive processing of task-relevant information and obtains data that is inaccessible by other methods.

W82-70608 **199-60-84**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED TELEOPERATION STUDIES
A. K. Bejczy 213-354-4568
(199-60-70; 906-75-27; 506-54-85)

The general objective of this RTOP is to develop both a scientific data base and models for understanding human performance in advanced space teleoperator systems. Since a broad class of future space missions will require 'man-in-the-loop' teleoperation, a validated understanding of human performance parameters is necessary to optimize man machine interaction in such systems. The specific objectives include the classification, measurement, and evaluation of human performance parameters related to: (1) kinesthetic and proprioceptive man machine coupling with emphasis on human performance in zero-g; (2) isomorphic and nonisomorphic man machine interaction and communication; (3) perceptive and cognitive processes involved in on-line decision making as a function of alternative presentations of a given teleoperator control task. The FY 82 objectives are: (1) complete the joint JPL/University study, initiated in FY 81, on the classification of critical human performance requirements for teleoperation in space; (2) complete the definition studies for zero-g kinesthesia, hand-eye coordination and decision analysis experiments; (3) continue or initiate instrumentation development needed for the experiments; and (4) support the introduction of RP measurement techniques at JPL (funded through RTOP no. 199-60-70). The general approach is experimental. To generate the necessary human performance data, the capabilities of the JPL teleoperator laboratory will be utilized. The experiments will employ physical and psychophysical measurement techniques already successfully applied in man machine systems research. University investigators will participate in the experimental studies and evaluations. Functional allocation between man and machine will be studied for various operational constraints, including time delays. New system and subsystem concepts will be developed and breadboarded where appropriate.

W82-70609 **199-70-31**
Lyndon B. Johnson Space Center, Houston, Tex.
GLOBAL TERRESTRIAL ECOLOGY
D. S. Nachtwey 713-483-5281

The ultimate goal of a Global Ecology Program is to quantitatively understand (i.e. mathematically model) the interrelationships of the Earth's entire biota and the entire lithosphere-hydrosphere-atmosphere system. Some of the elements required for this understanding have been outlined in reports from two workshops, 'Interaction of the Biota with the Atmosphere and Sediments' (Oct, 1979; Washington, DC) and 'Life from a Planetary Perspective: Fundamental Issues in Global Ecology' (Summer, 1980; Santa Barbara, CA). At the simplest level, the elements of global ecology consists of the biogeochemical reservoirs of the atmosphere, hydrosphere, lithosphere, and the biota, the increases of biogeochemicals between the reservoirs (sources and sinks), and the feedback interactions of the flow of biogeochemicals with each other and with solar radiation. It has become clear that perturbations of the balance of flows of specific chemical compounds between reservoirs can lead to significant alterations of the entire interrelated Earth system (e.g. anthropogenic CO2 increase can yield climate change; increases in methane, chlorofluorocarbons, and nitrogen oxides can yield ozone layer change accompanied by solar ultraviolet change). An approach to the global characterization of these elements, which was repeatedly proposed at the two workshops, is the application of remote sensing techniques coupled with ground truth sampling.

W82-70610 **199-70-34**
Jet Propulsion Laboratory, Pasadena, Calif.
STUDIES IN GLOBAL TERRESTRIAL ECOLOGY
Minoo N. Dastoor 213-354-7429

The objective of this RTOP is to establish a major role for JPL in support of NASA's Global Ecology Program by proposing an experimental, planning and analysis endeavor for the study of global biogeochemical cycles. The RTOP consists of three qualitatively different but programaticaly related, elements. The first element is an experimental and research effort, in conjunction with the Campus, to explore the possible biogenic origin and source strength of halocarbons, specifically methyl chloride in the ocean and the atmosphere using the GC-MS-EOID (Gas Chromatograph-Mass Spectrometer-Electro Optical Ion Detection) analytical methodology developed at JPL. Such a study would allow for an advanced and complete model of ozone modulation. The second element is to support NASA Life Sciences in the definition and development of a NASA Global Ecology Plan. Since this program is a new initiative, and addresses a complex problem, the need as well as the desirability of relating the various components (such as, dominant scientific issues, the roles of NASA and other federal agencies, implementation procedures) into a comprehensive plan is imperative. The third element will focus on the measurement and analysis strategy for global ecology research. It is anticipated that the science of global ecology will need methods through which large volumes of data are accumulated and analyzed.

W82-70611 **199-80-31**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED EQUIPMENT DEVELOPMENT
R. L. Frost 713-483-5991

The objective of this RTOP is the development of prototype hardware in support of both operational medical investigations during shuttle flights and possibly life sciences experiments during Spacelab flights. The hardware will be designed with flexibility in mind to allow the conduct of several similar investigations. This RTOP will provide for design studies, development for testing, and detailed design specifications for flight hardware. Contracts will be let to consolidate requirements and develop design requirements for hardware optimized to support several investigations. Prototype hardware will be procured and evaluations conducted to optimize the design. Detailed design specifications will be prepared to support procurement of flight hardware.

W82-70612 **199-80-42**
Ames Research Center, Moffett Field, Calif.
LONG DURATION LIFE SCIENCES SATELLITE PROGRAM DEFINITION
E. Gomersall 415-965-5730

The objective of this RTOP is to identify science issues, experiment requirements, and mission requirements for planning the conduct of nonhuman, biological research on spaceflights of long duration. The current limitation of the time-in-orbit of the Space Transportation System and the Spacelab may not permit a careful and unequivocal resolution of the various biological problems which confront man and other living organisms on spaceflights of long duration. Those questions need to be addressed to provide safe and reliable manned-flights for extended periods of time. In-house studies to identify life science questions and experiment scenarios will be used as a working basis for review by the science community. A Science Advisory Team will be appointed to provide interfacing activities to the MSFC Science and Applications Space Platform (SASP), MSFC manned platform, the JSC Space Operations Center (SOC) study activities, and in-house design assessments of future spaceborne research equipment.

W82-70613 **199-80-48**
Marshall Space Flight Center, Huntsville, Ala.
LONG DURATION LIFE SCIENCES (RESEARCH FACILITIES FOR SPACE PLATFORMS)
J. D. Hilchey 205-453-3430
(906-90-06; 199-80-42)

The objective of this RTOP is to conduct a study of man-tended life sciences research facilities (MT-LSRF) in order to: (1) determine

the feasibility of defining, developing, and integrating man-tended facilities applicable to the Science and Application Space Platform (SASP); (2) provide engineering data, costs, and schedules required to plan development of such facilities; and (3) prepare a synthesis of the results which will support a plan to proceed with a Phase B effort. A group of interrelated in-house and contract activities will include: (1) two parallel, competitively procured, contracted feasibility studies to provide accommodation concepts, interface engineering data, and programmatics of MT-LSRF for the space platform; (2) a similar in-house study extending work accomplished in FY 81; and (3) in-house synthesis of the results to provide a basis for deciding the Phase B course of action.

W82-70614 **199-90-71**
Lyndon B. Johnson Space Center, Houston, Tex.
INTERDISCIPLINARY RESEARCH
Lawrence F. Dietlein 713-483-6291

The development of a comprehensive biomedical research program in support of manned space flight is addressed. This broad, multidiscipline mandate to acquire new knowledge is directed toward the acquisition of definitive data regarding the effects of the space environment on life systems in order to define the critical physiological and psychological variables which must be integrated into the overall considerations of spacecraft designers and mission planners. The objective of the interdisciplinary is to provide flexibility in the accomplishment of this goal. The responsibility for planning, implementing, and continually evaluating the life sciences programs at Johnson includes the need to provide support for preliminary investigation of various alternative advanced research and technology efforts which might ultimately become part of an approved programmed RTOP assigned to the Center.

Solar Terrestrial & Astrophysics Data Analysis

W82-70615 **385-36-01**
Goddard Space Flight Center, Greenbelt, Md.
ATMOSPHERE-IONOSPHERE MAGNETOSPHERE INTERACTIONS
R. E. Hartle 301-344-8234

The basic objective of this RTOP is to study the observed properties of the inner magnetosphere, ionosphere, mesosphere, and thermosphere to identify and understand the physical and chemical processes operating in these regimes, emphasizing how they interact. This is achieved by processing, analyzing, and interpreting experimental data derived largely from flight programs permitting the study of long-term phenomena, comparison of data with new theories and models, correlative studies of data obtained from various satellites and ground based observatories, and the deposition of additional data in the National Space Science Data Center. The essential data to be used in this investigation include electron concentrations and temperatures, ion and neutral composition, neutral winds, ion temperatures and drifts, electric fields, magnetic fields, electromagnetic radiation and energetic particles of magnetospheric and ionospheric origin. These data are used: to determine the various interrelated chemical, compositional, dynamical, and energetic states of the inner magnetosphere, ionosphere, thermosphere, and mesosphere; and the transport and deposition of mass, momentum, and energy in and between these physical regions. These basic properties and processes are then used to analyze specific geophysical phenomena such as: electric field-induced ion drifts in the ionosphere and inner magnetosphere; chemistry and dynamics of mid and high latitude troughs; auroral substorms; ionospheric storms; Joule heating; PCA events; tidal and gravity waves; depletion and filling of plasmasphere; ionospheric plasma resonances; equatorial bubble formation; SAR Arcs; ring current decay, etc.

W82-70616 **385-36-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MAGNETOSPHERIC AND INTERPLANETARY PHYSICS: DATA ANALYSIS
Edward J. Smith 213-354-2248

This RTOP provides for the analysis and interpretation of scientific data from Mariner and Pioneer Vector Helium Magnetometers and from the OGO search coil magnetometers. The data have previously been reduced and are available for more intensive analysis and for use in studying problems of current scientific interest. The following general topics will be investigated: (1) the structure and dynamics of the magnetospheres of Jupiter and Saturn; (2) plasma waves inside planetary magnetospheres, in the magnetosheath, at, and upstream of, the bowshock and in interplanetary space; (3) the heliospheric magnetic field and solar wind including radial and latitudinal gradients, interaction regions, shocks, discontinuities and waves; and (4) the heliospheric magnetic field and energetic particles including cosmic rays and interplanetary proton streams. Available data will be supplemented by observations made by other spacecraft as the observations are published. The work will be carried out by members of the JPL Magnetic Fields Group in collaboration with investigators from outside the laboratory with whom working relationships have been established.

W82-70617 **385-36-02**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS - SPACE PLASMA PHYSICS
J. K. Alexander 301-344-5461

The basic objective of this RTOP is to study the observed properties of the interplanetary medium and the magnetosphere and to identify and understand the physical processes operating in these regimes, including how they interact. This is achieved by processing, analyzing, and interpreting experimental data derived largely from flight programs, permitting the study of long-term phenomena, comparison of data with new theories and models, correlative studies of data obtained from various satellites and ground-based observatories, and the deposition of additional data in the NSSDC. The essential data to be used in this investigation include measurements of magnetic fields, plasma waves, energetic particles, plasma, and kilometric radiation. These data are used to determine the various dynamical and energetic states of the interplanetary medium and the magnetosphere and the transport and deposition of momentum and energy within and between these physical regions. These basic properties and processes are then used in the study of specific geophysical phenomena such as interplanetary current sheets, energetic particle acceleration, auroral current systems, and magnetic fields and plasma in the magnetosheath and the magnetotail. Basic theory complementary to the data analysis effort is carried out in the areas of kinetic plasma physics and the motion of charged particles in electromagnetic fields.

W82-70618 **385-36-04**
Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLES AND PLASMAS IN THE MAGNETOSPHERES OF JUPITER AND SATURN
T. G. Northrop 301-344-7736

The objective of this RTOP is to gain an understanding of the sources, sinks, and dynamics of energetic (> 0.1 MeV) ions and electrons in the magnetospheres of Jupiter and Saturn. This work will apply plasma theory and the theory of charged particle motion to data taken by Pioneers 10 and 11, and by Voyagers 1 and 2. A study of the observed effects of Moons on the fluxes will be included.

W82-70619 **385-41-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS: ASTRONOMY
J. M. Mead 301-344-8543
(188-41-51; 188-41-55)

Tools and techniques to facilitate and improve the reduction, analysis and understanding of astronomical data will be developed. The application of computers for managing large blocks of observational and bibliographical information obtained at all wavelengths for stars, galaxies, and other extended objects will

be emphasized. The available data base will be expanded by (1) searching the journal literature, particularly in the infrared, to obtain more complete data and bibliographical coverage, (2) combining catalogs of variable stars, cool stars, and extended objects, and (3) using astronomical payloads in space to obtain spectrophotometric data on stars and interstellar matter. A Computerized Astronomical Data Retrieval System will be developed in order to provide data searches, digital plots, and bibliographical information for specified catalog ID numbers, positions and other parameters at ultraviolet, optical, infrared, and millimeter wavelengths. An Interactive Astronomical Data Analysis Facility will be designed and operated to provide astronomers with the display, enhancement, and analysis tools that they need to interpret their digitized images and spectra.

W82-70620 **385-46-01**
Goddard Space Flight Center, Greenbelt, Md.
HIGH ENERGY ASTROPHYSICS DATA ANALYSIS
F. B. McDonald 301-344-8801

The objective of this RTOP is to process, analyze, and interpret galactic, interplanetary, Jovian, and solar cosmic ray data from space flight experiments for detailed studies of phenomena involving multisatellite data sets. Multidisciplinary studies comparing experiment data from other satellites, deep space missions, and manned missions such as Skylab, as well as using ground-based observations to study in detail a wide range of high energy astrophysics phenomena will be conducted.

W82-70621 **385-46-03**
Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL HIGH ENERGY ASTROPHYSICS
R. Ramaty 301-344-8715

Fundamental research will be conducted in theoretical high energy astrophysics with particular emphasis on studies related to gamma ray and X-ray astronomy, cosmology, and cosmic ray and neutrino astrophysics. This program is in the forefront of theoretical research in these areas of astronomy and is pertinent to the overall observational and experimental program of the Laboratory for High Energy Astrophysics. Theoretical support in planning space experiments in high energy astrophysics will be provided and the theoretical framework created for the interpretation of the results from such experiments.

W82-70622 **385-46-04**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY ASTRONOMY DATA ANALYSIS
J. H. Swank 301-344-6188

Information about X-ray sources has grown steadily over the past few years with the discovery of new temporal and spectral phenomena in known sources, the resolution of new sources, and the identification of many with optical, infrared, or radio objects. The data bases of experiments contain as yet unexamined information about these sources. The data from Ariel 5, OSO-8, HEAO 1 and HEAO-2 span over 5 years and offer complementary information on the X-ray sky, including time variability of sources on time scales of milliseconds to years and spectra from 0.5 keV to 200 keV, in many cases with simultaneous coverage by other groups down to 0.2 keV and up to 10 MeV. It is proposed to study, using data from the All Sky Monitor on Ariel 5, the GSFC Cosmic X-Ray Spectroscopy Experiment on OSO-8 (GCXRS), the High Energy X-Ray Spectroscopy Experiment on OSO-8 (HEXRS), the HEAO A2 experiment, and the Solid State Spectrometer on the Einstein Observatory, sources showing yet unstudied variability, sources whose spectra have not been understandable with simple models, spectral-temporal correlations best studied with multiple observations and models recommended by recent theoretical work and observations in other wavelengths. These experiments also provide information on the detectors' particle background which would be of use to future missions.

Planetary Institutional Support

W82-70623 **404-02-01**
Goddard Inst. for Space Studies, New York.
RADIATIVE TRANSFER IN PLANETARY ATMOSPHERES
James Hansen 212-678-5593

The objectives of this RTOP are to apply techniques for extracting information on planetary atmospheres from radiation measurements, and investigate radiative, cloud and dynamical processes and their interactions in planetary atmospheres. Applications to Venus and Jupiter in progress are expected to yield general information on cloud, aerosol, and dynamical processes in planetary atmospheres, which will also help improve our understanding of the Earth's atmosphere and climate system. Principal elements in the approach are analysis of available spectral and polarimetric data for Venus and Jupiter to obtain information on atmospheric structure, cooperative studies with university researchers to investigate radiative, cloud, and dynamical processes, with focus on radiative/convective modeling of the atmospheres of Venus and Jupiter and study of cloud/radiation/dynamics feedbacks.

W82-70624 **404-03-01**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY INSTITUTIONAL SUPPORT - NATIONAL SPACE SCIENCE DATA CENTER (NSSDC)
James I. Vette 301-344-7354
(405-03-01; 406-03-01)

The National Space Science Data Center (NSSDC) was established to further the widest use of data obtained from scientific flight experiments by serving as an active repository. Information about satellites, probes, and rocket launches is also provided periodically through SPACEWARN Bulletins, Sounding Rocket and Spacecraft Launch Summary Report on Active and Planned Spacecraft and Experiments. The NSSDC actively collects data from about 135 experiments annually and is responsible for the organization and storage of magnetic tapes, microfilm, microfiche, photographs, punched cards, and hard copy and for the announcement, retrieval, reproduction, and dissemination of the data. Besides data, the acquisition of supporting information is essential to the efficient use of the data. The principal mode of contact for submission of data is through the Project Scientist to the Science Working Group. Schedules are established with each investigator and both the Program Scientist and Project Scientist are informed about adherence to schedules. For future missions, NSSDC provides a representative to the Project Science Working Group to definitize a Project Data Management Plan which will specify the quantity, form, format, and schedule of data submitted to NSSDC. With the photographic and computer facilities available, NSSDC is prepared to respond to approximately 1500 requests per year. Because of the nature of its activities, NSSDC is funded by the various NASA Program Offices who plan to deposit data in the active archive. The budgetary numbers here are the support that this Program Office is taxed for annual support.

W82-70625 **404-04-01**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY INSTITUTIONAL SUPPORT - CHARGED PARTICLE RADIATION MODELS AND FLIGHT PROJECT RADIATION ENVIRONMENT STUDIES
James I. Vette 301-344-7354
(405-04-01; 406-04-01; 406-07-01)

The need to constantly compare charged particle data in near Earth space is required to improve the accuracies of the previously produced model environments to at least a factor of 2. Flight Projects from all NASA field centers utilize these environments to determine the radiation or dosage expected in various planned orbits. The models, which are distributed for computational purposes, are sent as computer programs to requesters. The documentation of a model or the comparison of data with an existing environment is provided to all NASA field centers, NASA and DOE contractors, space workers in 14 foreign countries and in ESA. Since missions are always concerned with the radiation levels in the future, it is necessary to have

data extending back to the earliest satellite measurements in order to study long term effects. The six previously constructed electron models each have an epoch date or are representative of solar maximum or solar minimum conditions. The latest proton model has descriptions for these two solar periods. Studies for flight projects are conducted on request to determine fluence or dosage levels in the planned orbits. Solar flare protons are also taken into account from polar orbiting spacecraft or those at high altitude where the Earth's magnetic field cannot shield the radiation.

Astrophysics Institutional Support

W82-70626 **405-02-02**
Goddard Inst. for Space Studies, New York.
RESEARCH IN ASTROPHYSICS AT THE GODDARD INSTITUTE FOR SPACE STUDIES, COLUMBIA UNIVERSITY AND THE CITY UNIVERSITY OF NEW YORK
Patrick Thaddeus 212-678-5621
(405-02-03; 506-64-56)

This RTOP supports essentially all GISS research in astrophysics and detector development (only exceptions: 50K RTOP to Kerr on superconductor detectors and 25K RTOP to Cauto on cosmology). The objectives are to: (1) observe interstellar molecules at millimeter and far IR wavelengths; (2) develop receivers for mm waves and far IR; (3) undertake laboratory experiments at radio frequencies relevant to GISS observations; (4) conduct theoretical investigations of molecular collisions and molecular structure relevant to GISS astrophysics program; (5) undertake theoretical investigations of stellar structure and evolution with emphasis on neutron stars, X-ray and gamma-ray sources; and (6) conduct research in theoretical cosmology. The GISS research in astrophysics and the laboratory of very high frequency detectors is a collaborative effort between GISS scientists and personnel of Columbia Univ. and City Univ. of New York. In detector development there is close collaboration between GISS, Infrared Lab. of GSFC, and IBM Yorktown Heights Lab. Work is performed on GISS premises by research assistants working under supervision of GISS personnel holding adjunct faculty appointments at above institutions, primarily physics and astronomy students at Columbia and CUNY.

W82-70627 **405-02-03**
Goddard Inst. for Space Studies, New York.
RESEARCH IN ASTROPHYSICS AT THE GODDARD INSTITUTE FOR SPACE STUDIES
V. Canuto 212-678-5571

The objectives of this program are to carry out research in astrophysics, specifically in cosmology and neutron stars (pulsars). The predictions of the recently developed cosmological framework will be tested against cosmological data at high red shifts. The framework was developed to study the consequences of possible violations of the Strong Equivalence Principle, SEP, as recently suggested by radar ranging and lunar occultations experiments. Physical properties of neutron stars will be studied using X-ray data from Einstein Observatory. In order to test the validity of the SEP, one must first construct a framework that includes possible violations of such a principle whose magnitude is then determined by analyzing cosmological data like the brightness and angular diameters of OSO, the 3 degrees K degrees black body radiation, and nucleosynthesis, which is the earliest process for which there is direct observational data. The abundances of He4 and D are in fact crucial parameters that any viable cosmological theory must be able to explain. As for neutron stars, it is intended to perform a more reliable evaluation of the physical parameters necessary to understand the cooling mechanisms of pulsars, in accord with the most recent X-ray observations from HEAO-2.

W82-70628 **405-03-01**
Goddard Space Flight Center, Greenbelt, Md.
ASTROPHYSICS INSTITUTIONAL SUPPORT - NATIONAL SPACE SCIENCE DATA CENTER (NSSDC)
James I. Vette 301-344-7354
(404-03-01; 406-03-01)

The NSSDC was established to further the widest use of data obtained from scientific flight experiments by serving as an active repository. Information about satellites, probes, and rocket launches is also provided periodically through SPACEWARN Bulletins, Sounding Rocket and Spacecraft Launch Summary and Report on Active and Planned Spacecraft and Experiments. The NSSDC actively collects data from about 135 experiments annually and is responsible for the organization and storage of magnetic tapes, microfilm, microfiche, photographs, punched cards, and hard copy and for the announcement, retrieval, reproduction, and dissemination of the data. Besides data, the acquisition of supporting information is essential to the efficient use of the data. The principal mode of contact for submission of data is through the Project Scientist to the Science Working Group. Schedules are established with each investigator and both the Program Scientist and Project Scientist are informed about adherence to schedules. For future missions, NSSDC provides a representative to the Project Science Working Group to definitize a Project Data Management Plan which will specify the quantity, form, format, and schedule of data submitted to NSSDC. With the photographic and computer facilities available, NSSDC is prepared to respond to approximately 1500 requests per year. Because of the nature of its activities, NSSDC is funded by the various NASA Program Offices who plan to deposit data in the active archive.

W82-70629 **405-04-01**
Goddard Space Flight Center, Greenbelt, Md.
ASTROPHYSICS INSTITUTIONAL SUPPORT - CHARGED PARTICLE RADIATION MODELS AND FLIGHT PROJECT RADIATION ENVIRONMENT STUDIES
James I. Vette 301-344-7354
(404-04-01; 406-04-01; 406-07-01)

The need to constantly compare charged particle data in near Earth space is required to improve the accuracies of the previously produced model environments to at least a factor of 2. Flight Projects from all NASA field centers utilize these environments to determine the radiation fluence or dosage expected in various planned orbits. The models, which are distributed for computational purposes, are sent as computer programs to requesters. The documentation of a model or the comparison of new data with an existing environment is provided to all NASA field centers, NASA and DOD contractors, space workers in 14 foreign countries and in ESA. Since missions are always concerned with the radiation levels in the future, it is necessary to have data extending back to the earliest satellite measurements in order to study long term effects. The six previously constructed electron models each have an epoch date or are representative of solar maximum or solar minimum conditions. The latest proton model has descriptions for these two solar periods. Studies for flight projects are conducted on request to determine fluence or dosage levels in the planned orbits. Solar flare protons are also taken into account from polar orbiting spacecraft or those at high altitude where the Earth's magnetic field cannot shield the radiation.

Solar Terrestrial Institutional Support

W82-70630 **406-03-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR TERRESTRIAL INSTITUTIONAL SUPPORT - NATIONAL SPACE SCIENCE DATA CENTER (NSSDC)
James I. Vette 301-344-7345
(404-03-01; 405-03-01)

The NSSDC was established to help provide the widest use of data obtained from spore flight experiments by serving as an active repository. Information about satellites, probes, and rocket

launches is also provided periodically through SPACEWARN Bulletins, Sounding Rocket and Spacecraft Launch Summary and Report on Active and Planned Spacecraft and Experiments. The NSSDC collects data from about 135 investigations annually and is responsible for the organization and storage of magnetic tapes, microfilms, microfiche, photographs, punched cards, and hard copy and for the announcement, retrieval, reproduction, and dissemination of the data. It will develop on-line systems as funds permit. The acquisition mode for submission of data is through the Project Scientist to the Science Working Group. Schedules are established with each investigator and both the Program Scientist and Project Scientist are informed about adherence to schedules. For future missions, NSSDC provides a representative to the Project Science Working Group to define a Project Data Management Plan which will specify the quantity, form, format, and schedule of data submitted to NSSDC. With the photographic and computer facilities available, NSSDC is prepared to respond to approximately 1500 requests per year. Because of the nature of its activities, NSSDC is funded by the various NASA Program Offices who plan to deposit data in the active archive.

W82-70631 **406-04-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR-TERRESTRIAL INSTITUTIONAL SUPPORT - CHARGED PARTICLE AND RADIATION MODELS AND FLIGHT PROJECT RADIATION ENVIRONMENT STUDIES
James I. Vette 301-344-7345
(404-04-01; 405-04-01; 406-07-01)

New spore particle data from earth-spore ore needed to improve the accuracies of the previously produced model environments by at least a factor of 2. Flight Projects from all NASA field centers utilize these environments to determine the radiation fluence of dosage expected in various planned orbits. The models, which are distributed for computational purposes, are sent as computer programs to requesters. The documentation of a model or the comparison of data with an existing environment is provided to all NASA field centers, NASA and DOD contractors, space workers in 14 foreign countries and in ESA. Since missions are always concerned with future radiation levels, it is necessary to have data extending back to the earliest satellite measurements in order to study long term effects. The six previously constructed electron models each have an epoch date or are representative of solar maximum or solar minimum conditions. The latest proton model has descriptions for these two solar periods. Studies for flight projects are conducted on request to determine fluence or dosage levels in the planned orbits. Solar flare protons are also taken into account from polar orbiting spacecraft or those at high altitude where the Earth's magnetic field cannot shield the radiation.

W82-70632 **406-05-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR TERRESTRIAL INSTITUTIONAL SUPPORT - SATELLITE SITUATION CENTER (SSC)
James I. Vette 301-344-7354

The SSC was implemeted to coordinate a world wide, international observing and analysis program, the International Magnetospheric Study (IMS) to understand the plasma environment of the Earth. In order to plan and carry out coordinated measurements by balloons, rockets, aircraft, ships, ground based stations, and satellites, the positions of certain satellites are required weeks in advance. The SSC can provide: (1) the positions of high altitude satellites up to 6 months in advance, (2) identification of special intervals when these satellites have special configurations that will enhance knowledge if data are taken, (3) tabulation of crossing times of model boundaries or regions, (4) the identification of times when low altitude or geostationary satellites or ground stations are on the same magnetic flux tube as DE, ISEE 1, and SCATHA on a weekly basis up to 6 weeks in advance, and (5) notification to specific rocket ranges or ground based networks of user specified criteria about satellite positions in support of a campaign. All of these services increase the scientific return from the solar terrestrial research satellites. The DE project is planning to use conjunctions between DE-A and -B as major data acquisition criterion. After the coordinated observations have been made, the scientists require, in the data analysis phase, the retrospective information about satellite achieved positions, data acquisition, status of data processing, and the occurrence of solar terrestrial events. This capability will continue to function to support solar terrestrial research in the post IMS era both in data acquisition and analysis.

W82-70633 **406-07-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR-TERRESTRIAL (ST) INSTITUTIONAL SUPPORT - ST DATA ANALYSIS WORKSHOP CENTER (DAWOC)
James I. Vette 301-344-7354
(404-04-01; 405-04-01; 406-04-01; 406-05-01)

The analysis of data obtained on a coordinated global scale, such as has been acquired during the International Magnetospheric Study (IMS) is addressed. A new mechanism is required to build coordinated data bases and to bring scientists together for data display, comparisons of parameters from numerous instruments, and preliminary investigations of theoretical ideas. To support the formal data analysis phase of the IMS in 1980-85 and the continuing space research program carried out by NASA, particularly in solar terrestrial physics, a DAWOC at NSSDC was established in FY 80. The DAWOC uses the conference facilities, interactive graphics computer system, audiovisual equipment, and expertise available at NSSDC to construct and service problem oriented, multisensor data bases to advance the knowledge of near Earth space in a more efficient manner. Major workshops at the facility involve about 30 to 50 scientists. Servicing of the data base may continue for several years. The DAWOC staff provides a liaison for each committee to provide guidelines for data submission and guidance on the use of on site facilities and services. The DAWOC staff enters the data into an on line disc data base for interactive manipulation, time averaging, and display. Organization of such a data base is determined by the organizing committee. Development of new capabilities based on user inputs is a continuing activity.

ATD-Advanced Missions

W82-70634 **689-07-00**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR CORONA EXPLORER SCIENCE STUDY FOR A SOLAR SATELLITE MISSION
David Suddeth 301-344-7697

The purpose is to develop the scientific and technical basis for an Earth orbiting Solar Corona Explorer (SCE), proposed for flight in 1988 to 89. This mission is planned to increase understanding of the physics of the solar corona. It will carry an appropriate payload of instruments to meet the mission objectives and will be placed in an orbit that will permit optimal Sun observation within the mission requirements. The definition of the mission will include assessment of collaborative studies with other spacecraft such as the International Solar Polar Mission (ISPM), the Origin of Plasmas in the Earth's Neighborhood (OPEN), and the interplanetary physics laboratory (IPL). Objectives are to conduct preliminary system design feasibility studies in the areas of instrument requirements, mission analysis, systems definition, and data handling systems and to meet requirements established by the Solar Terrestrial and Astrophysics Program Office and its appointed science working group. The studies will be done in-house by the Preliminary Systems Design Group (PSDG) in such areas as science, sensors, mission analyses, engineering studies, information handling systems, and management guidance to prove feasibility or cost effectiveness of alternate approaches. These studies will contribute to the publication of a Preliminary Execution Phase Project Plan (PEPPP), planned for FY-83.

W82-70635 **689-08-00**
Jet Propulsion Laboratory, Pasadena, Calif.
EXTREME ULTRAVIOLET EXPLORER (EUVE) DEVELOPMENT FLIGHT PROJECT
James King, Jr. 213-354-7546

Assuming successful conclusion of prior Development Flight

Project work at JPL and the University of California at Berkeley (UCB), this RTOP covers continuing pre-project efforts through the first half of FY-82 (October 81 to April 82). By this time frame, the JPL and UCB groups will have become an integrated pre-project team. In FY-82 JPL will contract with UCB so as to continue funding the prototype telescope development now funded by GSFC. The JPL-UCB contract will also cover costs of UCB preparations for the flight project.

Sounding Rockets--Astrophysics, Solar Terrestrial, and Planetary

W82-70636 **879-11-36**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS: SPACE PLASMA PHYSICS INVESTIGATION
James P. Heppner 301-344-8797

The objective of this work is to perform measurements and experiments that will lead to an understanding of the interactive processes that occur between neutral gases, plasmas, energetic particles, and electric fields in the atmosphere, and near earth magnetosphere. Emphasis is placed on measurements and experiments that utilize the unique characteristics of sounding rocket trajectories and/or the low cost, quick reaction sounding rocket approach which permits program flexibility. This approach has logically been extended to include: (1) piggyback payloads on the orbiting upper stage of two stage Delta vehicles; (2) experiments involving sounding rocket flights in association with simultaneous satellite measurements in selected geometrical coincidence between trajectories; (3) flight testing of new instrumentation and measurement techniques; (4) shuttle ejection of low cost, rocket type payloads in the EOP (experiment of opportunity) mode; and (5) investigations of the electrodynamics of the middle atmosphere (i.e., below 90 km) using sounding rockets for deploying payloads which descend via parachutes.

W82-70637 **879-11-38**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS - SOLAR PHYSICS
Robert D. Chapman 301-344-5101

The sounding rocket program provides unique capabilities to conduct a broad range of scientific investigations. The program is particularly important for the development and demonstration of the merit of new instruments for shuttle flights and of prototype instruments for satellites. Furthermore, the short lead time and program flexibility make it possible to follow up new discoveries and to study particular phenomena on the Sun and in the Earth's atmosphere. Extreme ultraviolet spectra (EUV) of the Sun are a valuable tool for determining the true physical conditions in the solar corona. The main objectives are the determination of the flow of matter and energy from one region to another in the corona. For this purpose one needs to know the coronal density, temperature, gas velocity, and radiation field. The work under this task is directed toward the development and flight on rockets of instruments or determining these four physical parameters in the corona. A better determination of the characteristics of the solar corona is necessary in order to discover the paradoxical reasons why a coronal gas temperature of more than one million degrees can be maintained by energy from a region whose temperature is only five thousand degrees. These measurements are also important for determining the origin of the solar wind, which may arise from regions of open magnetic field.

W82-70638 **879-11-41**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS EXPERIMENTS (ASTRONOMY)
T. P. Stecher 301-344-8718

The astronomical sounding rocket program provides a unique capability to conduct a broad range of scientific investigations. The program flexibility and short lead time make it possible to observe unusual physical phenomena for which satellite instrumentation is not available. The program flexibility makes it possible to expenditiously follow-up discoveries as well as to provide tests and calibrations of satellite instrumentation. This unique capability is exploited by obtaining one of a kind observations of those types of astronomical phenomena that do not need large amounts of repetitive data to delinate their physical processes. Many new types of observations are now possible because of recent technical advances in both attitude control and new detectors. These observations are necessary in order to understand and analyze many properties of the interstellar medium, stars, nebulae, and peculiar galaxies. The present objectives are to develop payloads to obtain ultraviolet images of the weak sources now accessible as a result of improved pointing devices. Old payloads will be improved and used again and new payloads will be developed to take advantage of modern sensors and image intensifiers. The properties of galaxies and peculiar galaxies will be studied by means of their ultraviolet images. Procedures for absolute photometry of the stars and galaxies will be investigated. All instrument development will be done in such a manner that the instruments can be used on Spacelab or as Shuttle Experiments of Opportunity (EOP).

W82-70639 **879-11-46**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS (HIGH ENERGY ASTROPHYSICS)
E. A. Boldt 301-344-5853

High energy astrophysics (especially X-ray astronomy) is a rapidly evolving field of research, both scientifically and technically. The exploitation of the capabilities of short lead time, planning flexibility, accurate pointing and extremely high telemetry rates affored by sounding rockets is most important). A vigorous elaboration of this activity is now necessary for continuing to make timely and important contributions that complement satellite missions and for the effective planning of advanced future missions. This involves experiments with systems incorporating newly developed spectrometers and X-ray concentrators.

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

Supporting Research and Technology

W82-70640 **310-10-23**
Goddard Space Flight Center, Greenbelt, Md.
SOFTWARE ENGINEERING TECHNOLOGY
Frank E. McGarry 301-344-5048
(310-10-26; 323-53-03)

The objective of this RTOP is to identify, evaluate, and refine software engineering technology as applied to 3 disciplines of software: development, management, and maintenance. The software engineering technology to be studied includes software methodologies (such as design techniques, structured implementation techniques, and design evaluation techniques), software tools (such as management support tools, code auditors and analyzers, and automated design tools), and software support models (such as resource estimation models or reliability estimation models). The identified methodologies are intended to significantly reduce the overall life cycle costs of the software within the Mission and Data Operations area. The approach to attain the stated objectives includes the establishment of a laboratory environment through which the identified areas of software technology can be investigated, measured, and refined under suitable conditions. The laboratory will support the research effort in the area of software development, management, and maintenance. Within the laboratory environment, candidate technologies will be identified, appropriate measures to be used in the evaluation process will be developed, a data collection scheme will be identified, and the experiments will be conducted where the candidate methodologies will be applied to software development and maintenance tasks. This is a systems level RTOP supporting the areas of TDRSS Operations, Mission Support Computing, and Mission Operations.

W82-70641 **310-10-26**
Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE/ORBIT TECHNOLOGY
Arthur J. Fuchs 301-344-6846
(506-61-56; 310-20-27; 310-20-33; 310-40-46)

The objectives are to develop, evaluate, and demonstrate new technology for attitude and orbit determination/prediction/analysis for both ground based and onboard application, including algorithms, techniques, software, and hardware. The technology developed under this RTOP supports the space tracking and data system in the areas of mission computing and analysis, TDRSS operations, and data processing. Task 1 is orbit determination analysis: various techniques, algorithms, and filters will be developed and compared for their applicability to automated navigation either onboard or ground based. Task 2 is attitude analysis: modeling of various sensors including imaging devices such as TM and MLA along with horizon sensors, gyro, and star trackers will be utilized in error analysis software to develop and analyze new attitude determination and control configurations. Task 3 is GCP navigation: analyze various ground control point (GCP) processing algorithms, and design automated techniques for GCP registration. Task 4 is microprocessor based navigation: onboard as well as ground based applications of microprocessor based orbit and attitude determination systems will be investigated.

W82-70642 **310-10-42**
Goddard Space Flight Center, Greenbelt, Md.
PRECISION TIME AND FREQUENCY SOURCES
Victor S. Reinhardt 301-344-5946
(644-03-05; 676-59-35)

The objectives of the RTOP are to develop improved frequency and time standards, to improve existing hydrogen maser frequency standards, and to develop associated time and frequency distribution and measurement systems for VLBI and near Earth and deep space tracking. Both NR and NP masers will continue to be upgraded. Major improvements planned are a quartz cavity for both masers. Work will continue on the low cost maser. Next year key elements will be tested in other masers. The external bulb maser will be operating by next year, and will undergo extensive testing and evaluation. Work on a remote distribution and measurement system will be postponed to await results from 676-59-35 which impacts this development.

W82-70643 **310-10-60**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO METRIC TECHNOLOGY DEVELOPMENT
P. S. Callahan 213-354-4753
(310-10-62; 310-10-63; 310-10-64)

The broad objective of this RTOP is development of advanced metric systems used by the DSN for spacecraft navigation and radio science. The navigation requirements which will be placed upon the DSN by future deep space missions are expected to be stringent. In order to navigate missions to the outer planets a ten fold increase in data accuracy is required. The techniques having the greatest potential for improved navigation accuracy utilize Very Long Baseline Interferometry (VLBI). Current development efforts are focused upon a differential VLBI measurement scheme, referred to as Delta VLBI. This method involves the differencing of measurements from a spacecraft and from an angularly-nearby extra galactic radio source (EGRS). Common mode errors in the measurements cancel thereby providing precise EGRS-relative position information. Near-term goals are to demonstrate 50 nanoradian Delta VLBI capability and provide the technology development required for EGRS-relative spacecraft navigation, such as the planetary ephemeris-EGRS reference frame tie and identification of radio sources useful for deep space navigation. VLBI data is also used to support navigation thru the determination of Earth platform parameters and EGRS positions. The long-term goal here is to develop and demonstrate a VLBI system capable of 5 nanoradian accuracy. Near-term objectives include: (1) demonstrate 1 cm delay measurements on a short baseline; (2) add Earth interior and atmospheric models to data analysis software; and (3) improve EGRS positions and structures to achieve 5 nanoradian accuracies. Other work in radio metric techniques will: (1) provide an end-to-end study of two-way X-band Doppler system stability, with the near-term goal of 1 part in 10 to the 15th power; (2) investigate the use of spread spectrum signals in VLBI and Delta VLBI; and (3) develop methods for calibrating tropospheric and ionospheric effects on radio metric data to 2 cm.

W82-70644 **310-10-62**
Jet Propulsion Laboratory, Pasadena, Calif.
FREQUENCY AND TIMING RESEARCH
R. L. Sydnor 213-354-2763
(310-10-61; 310-10-64; 310-10-68)

The emphasis on outer planet missions, new and more accurate radio science experiments, and the increased need for automatic station operation necessitates the development of a new generation of frequency standards, frequency and time distribution equipment and monitor and control systems. The present frequency and time requirements of the DSN of 10 to the -14th power and 100 nsec must be improved by the mid-1980's to 3 x 10 to the -16th power and 10 nsec. The goal for the late 1980's and early 1990's is 10 to the -17th power and one nsec. Distribution of these references within a site and complex must be done in a manner which does not substantively degrade the performance. The overseas complexes must be synchronized to the master station at DSS 14 to 10 nsec. Automatic monitoring with near real-time performance assessment and centralized control are needed to maintain the performance and assure the reliability of the frequency and timing system. The reliability of all components of the system must be increased to ensure the availability of the required performance at all times and to reduce the life-cycle and M&O costs. The work in this RTOP to meet goals is divided into four areas: (1) frequency standards - the reliability of the present masers must be improved by development of longer life components and different technologies. New types of frequency standards (in particular trapped ion) will be developed to meet the longer term goals of performance; (2) frequency and time distribution - microwave, fiber optic, VLBI and satellite frequency and time distribution and synchronization systems will be developed for ultra-stable distribution goals of reference signals over distances ranging from 10 meters to 20,000 km; (3) phase coherent switch - the key technologies for real-time switching of frequency standards upon failure must be developed; (4) station stability - the end-to-end performance of a DSS must be evaluated to determine system components which limit Doppler stability. The near-term goal is to measure station stability to 3 parts in 10 to 16th power in support of the X-band uplink demonstration.

W82-70645 **310-10-63**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE SYSTEMS AND NAVIGATION TECHNOLOGY
J. Ellis 213-354-2788
(310-10-60)

The basic objectives of this RTOP are to identify the anticipated navigation requirements for deep space and High Earth Orbiter (HEO) missions proposed for the 1985-2000 era and to assess their implications on the DSN radio metric tracking system. The RTOP concentrates on three broad areas: determination of radio metric data requirements and evaluation of navigation options for meeting future project goals; automation of navigation data processing; and system level studies of proposed new space systems related to navigation. The specific objectives for FY-82 are: (1) assess the navigational accuracy requirements for the current deep space and HEO mission models and determine the DSN capability for meeting anticipated requirements; (2) evaluate the impact of DSN Earth orbiter navigation support on the radio metric tracking system; (3) formulate and analyze new navigational concepts such as the application of interplanetary beacons, lunar-based tracking stations, and optical frequency communication links; (4) complete the system design and implementation plans for navigation data processing automation; and (5) conduct system level studies to define requirements for an orbiting deep space antenna (ODSRS) and to plan proof of concept demonstrations using a proposed orbiting NASA spacecraft.

W82-70646 **310-10-64**
Jet Propulsion Laboratory, Pasadena, Calif.
X-BAND UPLINK DEVELOPMENT
R. B. Kolbly 213-354-1662
(310-20-65; 310-30-68; 310-30-70; 310-10-62)

The broad objective of this RTOP is the development of a phase-stable multikilowatt automated wideband X-band uplink capability for future DSN missions. This objective is being met by development of a 20 kW transmitter system operating at 7.2 GHz with frequency stability of five parts in 10 to the -15th power. It will be ready in mid-1983 for an X-band uplink demonstration in the DSS 13 unattended operations test bed. Specific FY-82 objectives include: (1) evaluation of the transmitter and exciter subsystem; (2) evaluation of a new microwave antenna feed cone, including diplexer, transmitter new S-X feed developed under RTOP 65; (3) telecommunication system support in preparation for the demonstration; (4) design and fabrication of a breadboard 7.2 GHz cryogenically cooled diplexer; (5) design of a 32 GHz test bed transmitter and travelling-wave resonator; and (6) continued support for planetary radar by maintenance and operation of the high-power radar transmitters at DSS 14. Long term objectives include development of a simultaneous S and X-band uplink capability, development of more reliable superpower X-band transmitter capability, development of cryogenically cooled diplexers, and development of K-band (32 GHz) transmitter capability. X-band uplink provides an alternative for the congested S-band uplink and more reliable command and telemetry performance while in two-way lock near solar conjunction. The wide bandwidth ranging possible with X-band uplink promises more precise navigation and radio science. The high phase stability enhances the probability of gravity wave detection. Automation supports the continuing test bed at DSS 13 to verify enhanced network productivity through automation, and to provide protection to high power, high-cost components from operator errors.

W82-70647 **310-20-27**
Goddard Space Flight Center, Greenbelt, Md.
NETWORK TIMING AND SYNCHRONIZATION TECHNOLOGY
A. R. Chi 301-344-7502

The objectives are to study and develop time synchronization techniques, to coordinate time determining methods and dissemination formats, and to conduct theoretical investigation and experimental verifications for NASA applications and for use in autonomous spacecraft. The approach is to develop a prototype design of a ground to satellite time transfer system with which to construct an engineering test model to conduct system test and system calibration. The time transfer technique is that of a PN coded time signal transmitted from a ground station via a synchronous satellite to the user. The propagation delays through the equipment and the medium can be measured and/or predicted depending on the accuracy requirements of the user. Study results show that the system concept and preliminary hardware design are compatible with the tracking and data relay satellite system (TDRSS) design and applicable to the new data management concept and the planned goal to achieve spacecraft autonomy. Further, the capability of the system design can achieve an accuracy of 1 to 10 microseconds using one way transmission from ground to satellite and 50 to 75 nanoseconds without correction and 1 to 10 nanoseconds with correction for Doppler, gravitation potential, etc., using two way transmission from ground to satellite and return.

W82-70648 **310-20-38**
Goddard Space Flight Center, Greenbelt, Md.
SATELLITE COMMUNICATIONS TECHNOLOGY
D. D. Wilson 301-344-5257

The objective of this RTOP is to introduce efficient high rate digital telecommunications transport systems to support NASA programs by 1985. The work focuses on two major tasks whose objectives are: (1) to define and demonstrate an efficient multinode satellite based high rate digital telecommunications system which can provide to geographically dispersed users, multiple access on a demand assignment basis and (2) to define and demonstrate advanced signal processing and coding techniques which could provide an improvement in data transmission speed and performance through 36-MHz C-band domestic satellite transponders. The approach for each task is as follows: (1) define the system requirements and resultant network architecture, then develop and demonstrate the system elements including low cost implementation of time division multiple access (TDMA) terminals, monitor and control terminals, digital voice Codec, forward error correction Codec, and digital television at 20 MB/S Codec; and (2) evaluate the feasibility of combining the best performance of signal processing and coding elements to provide 90 MB/S or higher transmission through a C-band transponder at 1x10 to the (-7th) power BER and 99.5 percent EFS with specified satellite system characteristics.

W82-70649 **310-20-46**
Goddard Space Flight Center, Greenbelt, Md.
TECHNOLOGY FOR TDRSS USER SPACECRAFT
R. P. Hockensmith 301-344-9067
(506-20-46)

The objective of the work under this RTOP is to achieve technological advances in radio frequency (RF) systems, antenna systems and associated control technology, and in telecommunications coding. These developments will satisfy future requirements of space mission users (spacecraft and space transportation system payloads) that require near global coverage by the TDRSS for support of the missions. The approaches for accomplishing the objective are to: (1) identify the basic operational communication requirements; (2) investigate RF active and passive components and antenna systems that are feasible, but may be a technical risk, to attain the required RF performance; (3) investigate methods of reducing torque noise induced into space platforms due to electromechanical steering of large gain antennas; (4) develop system designs incorporating these optimum subsystems to permit user projects to specify proven, reliable hardware with a high confidence level in the performance capability, cost, and required procurement cycle; (5) investigate outer telecommunication coding schemes which are transparent to data formats, and develop a high data rate encoder that is independent of the mission data formatting; (6) improve command throughput capability by an order of magnitude by coding techniques; and (7) exploit necessary improvements in testing techniques that properly characterize these critical systems.

W82-70650 **310-20-65**
Jet Propulsion Laboratory, Pasadena, Calif.
ANTENNA SYSTEMS DEVELOPMENT
W. Imbriale 213-354-3872

The broad objectives of this RTOP are to develop the technology for enhancing the communications capabilities of the DSN antennas at the existing S and X-band operational frequencies and to enable the support of future missions at higher (Ka-band) frequencies. In addition, the technology is being developed to enable a credible cost and performance tradeoff between a clear aperture and a center fed antenna for the replacement of the DSS 13 antenna which is scheduled in the 1985-1990 time frame. Advances in ground antenna performance capabilities are accomplished by integrating microwave, structural, mechanical and control system technologies. Microwave technology is applied to provide new feed designs with wider bandwidths and improved noise performance and to develop new optics concepts such as the clear aperture antenna and shaped, quasi-paraboloidal surfaces with greater aperture efficiency. Efficiency improvements may be achieved through improved structural, mechanical control and alignment procedures, and through electronic compensation of the microwave surfaces. The objectives are being met by (1) development of a feed for simultaneous reception and transmission of both S and X-band, (2) determining the benefits, both RF and mechanical, of a clear aperture antenna concept, and (3) identifying a methodology for developing new structures or utilizing the existing antenna structures for Ka-band operation. Specific FY-82 objectives include: (1) install the completed dual frequency (S/X) antenna feed cone on DSS 13 and measure its performance; (2) assemble and test an RF proof-of-concept model for the clear aperture antenna; (3) extend structural and microwave-oriented antenna design software to accommodate Ka-band; (4) study low cost fabrication techniques for Ka-band surface panels,

and (5) develop concepts for a Ka-band antenna mechanical-structural system in the diameter ranges from 26 to 64-meters.

W82-70651 **310-20-66**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO SYSTEMS DEVELOPMENT
D. L. Johnson 213-354-4942
(310-20-65)

The objective of the achievement of greater network performance and availability through the development of improved ground receiving elements of the spacecraft-to-ground telecommunications link. Future missions will require phase-stable, versatile, low-cost, reliable and efficient receiver elements which permit ultra-stable sensitive wideband reception of signals at Ka-band (32 GHz) or the simultaneous reception of S and X-bands. One such receiving system is a multifrequency upconverter, operating at S, X and Ka-band, with a wideband Ka-band traveling wave maser, all in one cryogenic refrigerator. This single wideband unit would be available for all DSN frequencies instead of requiring the logistical support of three separate maser packages. Another element is a reliable and efficient long-life closed cycle refrigerator (CCR) to hold the 3 watt maser package at 4.5 Kelvins. Other elements are a compact wideband Ka-band maser, cryogenically cooled ultra-low loss bandpass filters to provide in-band and out-of-band interference rejection, and a high performance wideband digital receiver. Future missions will also require noise temperature calibration and modeling of the propagation medium and of the DSN radio parameters for efficient link design. Calibration and modeling of the propagation medium and DSN radio parameters requires thorough monitoring and establishment of a data base of the statistics of meteorological effects at S, X, and Ka-bands. Specific FY-82 objectives include: complete development of a Ka-band traveling wave maser; integrate and test the X to Ka-band and S to Ka-band parametric upconverters; measure RFI effects on existing S and X-band masers; develop and demonstrate S and X-band fixed tuned filters; fabricate and test engineering model magnetic cooling stage for 4 Kelvin refrigeration; continue evaluation of regenerator materials for enhanced refrigerator performance; complete development and field test a Ka-band radiometer; begin the development of a Ka-band down converter, required for a 32 GHz maser/digital receiver interface; and initiate the development of digital tuning techniques and Fast Fourier Transform techniques for the wideband digital receiver.

W82-70652 **310-20-67**
Jet Propulsion Laboratory, Pasadena, Calif.
TELEMETRY TECHNOLOGY DEVELOPMENT
R. G. Lipes 213-354-7058

The focus of the RTOP is the development of technology to meet anticipated telemetry needs of DSN supported missions in the 1985 time frame and into the 1990's. Among currently foreseen needs in this time frame are support of the Voyager Uranus encounter, extensive antenna arraying capabilities called for the Networks Consolidation Program (NCP), expansion of telemetry data reception rates to accommodate missions such as VOIR, and provision of a communications link at the far outer planets capable of realtime video transmission. In addition, the GALILEO and ISPM project telemetry requirements call for links that can deliver bit error rates (BER) below one part in a million. The DSN support of Voyager Uranus encounter and development of antenna arraying capabilities are to be partially accomplished through work units leading to a carrier combining demonstration in FY-83. This work, to be carried out in parallel with the NCP sponsored baseband combining demonstration, will demonstrate array acquisition and tracking strategies, carrier reference combining, and baseband telemetry combining. Current demonstration plans call for the signals from the antennas being arrayed to be too weak for individually acquiring carrier loop lock, so this arraying will demonstrate a telemetry capability which is not possible with baseband arraying alone. Moreover, work units in telemetry system analysis and coding efficiency are expected to provide techniques for a 1 dB SNR improvement at Uranus encounter and for achieving BERs of 0.0000010 required by ISPM. Technology for expansion of telemetry reception rates to accommodate VOIR mission needs will be developed by completing current work on the multimegabit telemetry system. Optical deep space communication links to the far outer planets could provide a feasible means for realtime video in the last decade of this century. To initiate development of the technology, a laboratory optical communication system capable of providing 2.5 bits of information per detected photoelectron at 100 Kbps rate will be demonstrated in FY-81.

W82-70653 **310-30-68**
Jet Propulsion Laboratory, Pasadena, Calif.
STATION MONITOR AND CONTROL TECHNOLOGY
C. F. Foster 213-354-5070
(310-20-64)

The objectives of this RTOP are the development and demonstration of technology for unattended tracking station operations, and the generation of a data base for assessment of the impact of unattended operations on network productivity and network life cycle costs. The approach used is the development of a test bed remote controlled unattended station at DSS 13. This test bed includes automated control of an unattended 26-m antenna, transmitter, receiver subsystems, and data processing subsystem. Control of the equipment is from JPL. This test bed has evolved over several years to include an increasingly comprehensive set of subsystems. Six-month unattended receive capability was demonstrated at DSS 13 during FY-78 and 79 to provide life cycle cost data. Unattended transmit capability will be demonstrated for two months in FY-80 and 81. Standard DSN semi-automated command processing equipment (e.g., CMA, TPA) has been installed for support of uplink command demonstration in FY-82. Emphasis in FY-82 is on improving remote operator interface by simplifying type-ins, and by automation of the traveling wave maser, closed cycle refrigerator (CCR), ranging subsystem, and X-band exciter/receiver. Additionally, automation of preventive maintenance diagnostics of critical elements such as traveling wave masers, antennas, receivers, and transmitters is underway and will continue for several years.

W82-70654 **310-30-70**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH SPEED SIGNAL PROCESSING RESEARCH
G. S. Downs 213-354-2765

The purpose of this RTOP is to investigate, develop, test and demonstrate advanced signal processing techniques and equipment which enable real time data validation and relieve demands for high rate data recording and transmission. The engineering objectives are: (1) design, develop, build and operate a high-speed signal processing test-bed at Goldstone incorporating large scale integrated (LSI) circuits where possible; (2) apply this test-bed for real time acquisition and processing for several classes of potential users, including planetary radar users, high-rate telemetry validation for VOIR, antenna arraying, weak signal decoding, radio frequency interference (RFI) characterization and avoidance; and (3) characterize the RFI environment at Goldstone, providing data to the NCP effort. Since station use is typically for only one application at a time, rapid automated reconfiguration of the test-bed elements will permit one processor system to serve all user classes. This work contributes directly to improving signal-to-noise ratios, network reliability, and tighter operating tolerances. During FY-82 tasks are: upgrade the Goldstone signal processing test-bed with a VAX/780 supermini computer; design and construct 10 MHz, 8-bit A/D converters and correlations and integrate with the computer; design LSI macrologic building blocks for an LSI general purpose array processor; design the architecture for a 60 million floating point operations per second array processor (expandable to 300 million operations/sec for SAR validation); design the architecture for a 40 MHz, 4096-point FFT device; include auto-focusing in the SAR algorithm, and test the algorithms in the high-speed test-bed; obtain RFI data at S-band using the RFI trailer; obtain processed echoes from planetary surfaces with the higher power radar system.

W82-70655 **310-40-26**
Goddard Space Flight Center, Greenbelt, Md.
OPERATIONS SUPPORT COMPUTING TECHNOLOGY
C. J. McTavish 301-344-8447
(310-10-49; 310-10-23; 310-40-37; 310-10-26)

This is a subsystem level RTOP which is aimed at improving the accuracy, timeliness, cost effectiveness, and management of operational ground based orbit computations in the TDRSS era. It addresses the evolution of Operations Support Computing (OSC) technology into the late 1980's and beyond. This objective is accomplished through system studies to determine, develop, and analyze advanced operational concepts, management concepts, and computer system designs; and through concept test and evaluation via prototype implementation of specific capabilities in controlled environments. System studies in FY-82 will concentrate on the modeling of computer system designs developed in FY-81, investigating the applicability of array processing techniques for performing OSC functions, and developing concepts and techniques for OSC management. Other tasks will focus on the demonstration of human engineering and advanced operational concepts in the mission support computing environment. A Research and Technology Support Facility (RTSF) employing intelligent terminals will be implemented and dumb terminals will be enhanced to develop and demonstrate recommended concepts.

W82-70656 **310-40-37**
Goddard Space Flight Center, Greenbelt, Md.
HUMAN-TO-MACHINE INTERFACE TECHNOLOGY
Walter Truszkowski 310-344-6222

The overall objective of this RTOP is to develop and apply natural man/machine interfaces for space payload and ground system control. In this context natural means English-like. The intention is to apply recent advances in low cost computer/microprocessor hardware and artificial intelligence (AI) software techniques augmented with audio and touchtone input/output technology to the man/machine interface problems associated with such systems. The approach to be taken is: first, to identify and apply state of the art voice/touchtone technology to mission and data operations systems interfaces; second, to apply advanced knowledge representation techniques and methodologies in the development and application of user interfaces to various data/information bases actively used in the mission and data operations environment; and thirdly, to formulate a plan and investigate the feasibility of establishing a knowledge engineering lab environment to support near term application directed man/machine interface development and testing. This RTOP is a system level RTOP supporting TDRSS Operations, Mission Operations, and Mission Support Computing.

W82-70657 **310-40-45**
Goddard Space Flight Center, Greenbelt, Md.
MISSION OPERATIONS TECHNOLOGY
Roger V. Tetrick 301-344-9589

The Mission Operations Technology RTOP is a subsystem level RTOP. The objective is to transfer state of the art hardware, software, and automation technology to the mission operations environment to improve operations efficiency and reliability and reduce costs. This RTOP is divided into two tasks: Control Center Automation and Distributed Control Research. The Control Center Automation task seeks to develop a highly automated operations control center capable of supporting multiple simultaneous missions by the study and specification of the levels of automation for systems resource allocation, connection, test, and status reporting. The Distributed Control Research task will provide the technology required for a workable distributed mission control environment by the development and implementation of a distributed command management system and a software system synthesis concept for near real time configuration of command management software systems.

W82-70658 **310-40-46**
Goddard Space Flight Center, Greenbelt, Md.
IMAGE PROCESSING TECHNOLOGY
Frederick W. McCaleb 301-344-5470
(506-61-19; 656-26-03)

This RTOP supports the development and utilization of image processing technology. Currently there are three major objectives of this RTOP: (1) utilization of optical disk data storage technology in image processing systems; (2) development of automatic quality control (QC) capability for image processing systems; (3) improvement of the geometric/registration correction capability of image processing systems. These objectives are being pursued as three independent tasks. Task 1 pursues the development of the systems technology required to utilize optical disk recorder/reproducers for image data storage in image processing systems. Task 2 assesses available QC techniques to determine if they can be automated and identifies processing functions which cannot be automatically quality controlled. Task 3 uses the results of ongoing Image Processing Facility (IPF) geometric accuracy studies to develop recommendations as to how geometric correction should be implemented in future systems. This is a subsystem level RTOP supporting data processing.

W82-70659 **310-40-49**
Goddard Space Flight Center, Greenbelt, Md.
SYSTEMS MANAGEMENT TECHNOLOGY
Paul J. Ondrus 301-344-6912

The objective of this RTOP is to develop and validate concepts and techiques which can optimize the evolution and operation of Space Tracking and Data Systems (STDS). Its major objectives are: (1) the application of a cost benefit assessment methodology to certain STDS design issues and the development of system implementation guidelines, (2) the definition, design, and implementation of a cost allocation/prediction model for STDS subsystems, (3) the development of a baseline ground system architecture through the 1990 timeframe, and (4) the formulation of a research program to explore the nature of control and decision making in large scale decentralized systems. The RTOP approach is to develop associated tools and techniques, apply the techniques to representative STDS problems, and evaluate both the technique and its results prior to its operational introduction in STDS. The analysis of these specific issues and the development of the specified system management techniques are needed in order to provide an information base from which to improve the productivity and effectiveness of STDS systems during the 1980's. This RTOP is a system level activity supporting spacecraft data acquisition, TDRSS operations, data processing, mission operations, and mission support computing.

W82-70660 **310-40-73**
Jet Propulsion Laboratory, Pasadena, Calif.
NETWORK PRODUCTIVITY RESEARCH
J. H. Yuen 213-354-2081
(310-30-68)

The broad objective of this RTOP is to increase the effective use of resources for tracking and data acquisition support of NASA missions. This effort requires research at the system level in two distinct areas: telecommunications link analysis and information systems methodology development. Telecommunication system analysis involves feasibility and cost effectiveness studies of future development options and generation of techniques for quantitative assessment of network productivity. Likewise, information systems methodology development is directed towards improved network productivity through increased system reliability, operability, and maintainability and through decreased implementation costs. The approach used in this RTOP is three fold: (1) perform research under joint-sponsorship with TSPD at the DSN system level to assess the feasibility and cost effectiveness of future options for improving the planetary telecommunications capability; (2) develop economic tools, and software implementation and management techniques to permit quantitative assessment of network productivity and cost effectiveness; and (3) make detailed assessments of specific concepts which offer promise of meeting particular DSN needs, e.g., DSN data storage system. This allows the full impact of new technology or alternative methods of providing DSN services to be evaluated prior to the expenditure of large amounts of development and implementation funds. In FY-82, specific objectives are: (1) complete Ka-band flight-ground tradeoff study and cost analysis; (2) perform system level assessment of a deep space optical communication system; (3) develop mathematical models for simulation of DSN economic

performance characteristics; (4) support DSN Programming System development; and (5) evaluate and characterize DSN recording needs for the 1985-1995 period, and develop methodology for DSN data system design.

OFFICE OF SPACE TRANSPORTATION SYSTEMS

Advanced Programs

W82-70661 **906-50-00**
Marshall Space Flight Center, Huntsville, Ala.
POWER SYSTEM PLATFORM
Luther E. Powell 205-453-5310

The objective of this effort is the preliminary design (Phase B) of the power system and development of planning and cost data to support subsequent hardware design and fabrication contracts as well as the continuation of critical subsystems supporting development activities. In-house and contract studies have resulted in a description of a power system concept. The management of the Phase B studies and participation in all aspects of these studies through participation in study reviews, review of contractor documentation, correlation of related advanced development activities, and interfacing elements (STS, TDRSS, launch facilities, etc.) activities will be used as the basis for the Phase C/D effort. It will also provide the cost and schedule data required.

W82-70662 **906-54-00**
Lyndon B. Johnson Space Center, Houston, Tex.
MANNED ORBITAL FACILITIES
Richard C. Kennedy 713-483-3969

The shuttle provides this country with a new level of capability in transporting payloads to low Earth orbit (LEO) both from cost and on orbit operations standpoints, and it will effectively double the single launch mass capability to geosynchronous orbit (GEO). The shuttle system also has the capability for servicing satellites in LEO and for assembling systems which have an operational configuration somewhat larger than the orbiter payload bay. Commercial and defense requirements were established which necessitate extending large payload capability and manned operations out to GEO and beyond. The most effective way to do this is by establshing an operations center in LEO which, in effect, is a staging area (or forward base) for the ground to GEO transportation system; a station which supports the assembly, launch, recovery, and servicing of large unmanned payloads and manned modules for missions to GEO and back to LEO. This Space Operations Center would also provide the additional capabilities of constructing complex space systems too large for a single shuttle launch and of providing periodic servicing for co-orbiting commercial, science, and applications satellites. In FY-82 the major thrust will be the continuation of the funded and in-house system studies of the Space Operations Center (SOC) to be ready for an FY-83 Phase B go ahead.

W82-70663 **906-55-00**
Lyndon B. Johnson Space Center, Houston, Tex.
LARGE SPACE STRUCTURE SYSTEM ENGINEERING
Richard C. Kennedy 713-483-4083

The objectives of this RTOP are to develop an understanding of space construction requirements for NASA programs of the 1980's and to identify and develop the tools, techniques, ground test hardware, and flight development activities necessary to insure that these programs can be implemented when approved. (This activity complements the OAST funded large space structures technology activities conducted at JSC and other centers). Primary emphasis is in FY-82 will be to define and initiate ground and flight test programs and to define laboratory facilities and software required to understand interactions between the orbiter control system and large deployed structures. Additional effort will be devoted to crew interactions with deployable structures and to the continuing definition of a geodetic beam machine.

W82-70664 **906-55-01**
Marshall Space Flight Center, Huntsville, Ala.
LARGE SPACE STRUCTURES
James K. Harrison 205-453-2817

The objective is to develop the technology needed to build large structures in space to adequately meet the construction needs for projected applications such as second generation versions of the Science and Applications Space Platform (SASP) and the Geostationary Platform (GSP). Potential applications such as SASP and GSP provide the motivation, direction, and requirements for the needed technology and advanced development work. Two construction methods are being developed: space fabrication and deployable. The center piece of the space fabrication work is the development and test of a machine for manufacturing a composite structural member. The focus of the deployable work is the development and test of a deployable truss structure. Both have accompanying supporting activities and both are candidates for a flight experiment in the 1986 time frame.

W82-70665 **906-58-00**
Marshall Space Flight Center, Huntsville, Ala.
EVOLUTION OF SCIENCE AND APPLICATIONS SPACE PLATFORMS
C. C. Priest 205-453-2796

The objective of this effort is the concept definition (Phase A) of approaches and concepts for evolving unmanned and manned habitated platforms beyond the current Power System Platform concept (PSP Alpha) to an evolutionary goal of establishing a permanent manned presence in space. Phase A contracted and in-house studies have resulted in the definition and analysis of an unmanned science and applications space platform (PSP Gamma) configuration and manned space platform (PSP Beta) configuration. The FY-82 effort will continue the definition and analysis of the steps in the evaluation of an early manned platform to a permanent manned facility. Additionally, the ground based deployable truss structure fabricated and initially tested in FY-81 will have deployment and dynamic testing completed in FY-82. Definition and analysis will be initiated on the operations associated with manned space platform module berthing/latching and Shuttle RMS utilization/modification requirements.

W82-70666 **906-63-00**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL TRANSFER VEHICLE (OTV)
Donald R. Saxton 205-453-2796
(506-63-29)

The objectives of the FY-82 work will be to conduct Phase A definition and technology studies of OTV concepts, subsystems, and evolutionary approaches. Particular emphasis will be placed on (1) investigation of alternative launch modes, basing options, missions; (2) establishing feasibility and providing definition/optimization of aeroassisted OTV concepts; (3) preparing a plan for development and verification of aeroassist technology; (4) conducting cryogenic breadboard and lightweight tank testing; and (5) analyzing on-orbit assembly of various interim upper stage (IUS) concepts. Phase A in-house and contract studies have resulted in several selected ground based Shuttle Orbiter compatible OTV concepts, both aeroassisted and all propulsive. The FY-82 activity will investigate concepts compatible with alternative launch and basing modes. A joint technology, advanced development, and system analysis activity to identify and conduct technology for aeroassisted OTV concepts initiated in FY-81 will be continued and expanded to cover all candidate concepts.

W82-70667 **906-65-00**
Lyndon B. Johnson Space Center, Houston, Tex.
SHUTTLE SYSTEMS/OTHER STS
Richard C. Kennedy 713-483-4083
(505-34-47)

In the several years since the Space Shuttle design has been definitized, a great number of technological innovations in avionics and mechanical systems have reached the development stage. In addition, new payload and mission requirements were identified which demand enhanced or augmented space transportation system (STS) capabilities. A continual process of evaluation

is required in order to develop and incorporate those required new capabilities either as retrofits to the Space Shuttle or as initial systems on emerging new STS initiatives.

W82-70668 **906-65-01**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE DERIVED VEHICLE (SDV)
M. A. Page 205-453-3425
(506-63-29)

The objectives of this effort are: to establish vehicle concepts and supporting facilities/equipment definition for shuttle-derived vehicles; to identify potential mission applications and benefits; and to determine representative costs and schedules for implementation. A contracted study is currently in progress to determine technology requirements for a variety of potential Shuttle-Derived Vehicle (SDV) concepts. Specific analyses of candidate current state of the art Shuttle-Derived Cargo Vehicles (SDVC) are being performed under advanced programs (code 906) FY-81 sponsorship. This FY-82 task will allow trade studies and conceptual definition of relatively low technology conepts employing reusable liquid booster(s). This will include trade studies to determine the benefits of fly back boosters, in comparison with the current down range recovery approach. The selected vehicle concepts will be defined in sufficient detail to allow technical and economic feasibility determinations. Operations, launch facilities, recovery systems, checkout, turn around, etc., requirements will be included in the concept definition. The Space Transportation System (STS) evolution toward future requirements, manned and unmanned, through new technology, product improvements, increased performance, and improved operations will be considered. Cost and schedules will be established.

W82-70669 **906-70-11**
Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE/TETHERED SATELLITE SYSTEM (TSS)
Jay H. Laue 205-453-4570

The objectives of the FY-82 work will be to: (1) perform special emphasis tasks that will deepen the definition of the more critical areas of the proposed Tethered Satellite System (TSS) concept and (2) perform advanced development of selected TSS flight type hardware elements, including ground test and evaluation. Phase A in-house and Phase B contracted definition studies resulted in concepts for a TSS to be used as a Shuttle borne facility for conducting scientific experiments and applications beginning in 1986. The FY-82 activity will be performed by one of the two Phase B contractors. Contractor selection will be by a competitive process and will be based on the Phase B contractor's response to a request for proposal (RFP) for a two phase development of the TSS. This RTOP addresses the FY-82 initial, or advanced development, phase of the development. The second phase, the design and development phase, is planned to be submitted for budget approval in FY-84 and if approved will lead to initial launch of the experimental flight TSS in early 1987. The experimental flight TSS will include engineering instrumentation and demonstration science experiment.

W82-70670 **906-71-00**
Lyndon B. Johnson Space Center, Houston, Tex.
MISSION PLANNING TECHNIQUES/TOOLS
S. Milo Keathley 713-483-5897

Mission planning for the operational era of the Space Shuttle imposes many unique new requirements. One of the early new functions will be the routine rendezvous and docking with payloads and Space Transportation System (STS) components for the purpose of retrieval, servicing, or repair. New software techniques, training procedures, and planning tools must be developed in order to accommodate these routine space activities. Of particular importance is the understanding of the mix between man and machine controlled functions. FY-82 will see the continuation of the effort initiated in FY-80 to examine the feasibility of automating rendezvous and proximity operations functions for the Space Shuttle during satellite servicing operations. A related task will look at aiding the pilot during close-in satellite operations through the TV display of selected relative motion parameters. This type of piloting aid would be a precursor to fully automated operations.

W82-70671 **906-75-00**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED ORBITAL SERVICES (TELEOPERATOR MANEUVERING SYSTEM)
J. R. Turner 205-453-4165

The objective of the FY-82 work will be to: (1) investigate, define, and develop the Teleoperator Manneuvering System (TMS) applications, requirements, and concepts to bring to the Space Transportation System (STS) a remotely controlled satellite placement, retrieval, and subsatellite capability in the mid 1980's with an evolution to other satellite services such as satellite maintenance/repair, large structures assembly, and retrieval of unstabilized satellites and space debris, and (2) develop the substantiating programmatic cost and schedule data to support NASA's proceeding with a Phase B TMS definition in FY-83 leading to an FY-84 new start. The TMS Phase A study initiated in 1980 and incrementally funded in FY-81 will be completed in FY-82. Supporting development in FY-81 includes procurement of a Shuttle Remote Manipulator System (RMS) end effector that will be evaluated during FY-82 for use as a docking mechanism. Evaluation of other docking mechanisms, lighting requirements, video and display requirements will continue to be investigated during FY-82. Bread boarding of long and short range radar systems will be completed and evaluated in FY-82 to assess applicability to the TMS and to determine new technology requirements. The TMS docking systems test and evaluations will be conducted and spacecraft servicing systems/control systems will be extended to include axial and radial exchange capability. Specialized end effectors for handling beams will be fabricated and tested in FY-82 to further refine concepts for TMS remote satellite applications.

W82-70672 **906-75-01**
Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE SERVICES
Richard C. Kennedy 715-483-4083

The Shuttle mission model identifies many payload deployment and retrieval requirements beyond the capability of the basic shuttle system. Satellites such as the Manned Maneuvering System (MMS) and large space telescope require periodic servicing. Studies of some future space systems show that longer operational lifetimes are necessary for long duration, low cost operation, and that a servicing capability including maintenance, repair, and refurbishment will be required. Studies of possible flux densities of nonfunctional satellites and debris in the year 2000 time period show results indicating potential hazards to space flight. It is now timely for the development of a satellite services capability for a cost effective means of meeting early payload needs and to meet longer term requirements for dealing with maintenance and satellite removal requirements. This RTOP includes the definition, design, development, fabrication, and flight testing for engineering and operational verification of key elements of a satellite services system. These services include deployment and retrieval of payloads, Earth-return, and general satellite support.

W82-70673 **906-75-26**
Langley Research Center, Hampton, Va.
DIRECT SIMULATION MONTE CARLO METHOD FOR CALCULATING THE RAREFIED FLOW FIELD OF A ROCKET EXHAUST
L. T. Melfi, Jr. 804-827-3718

The objective of this work is to develop a reliable method of calculating the flow fields. Data on the flow field properties are required to analyze and predict the forces and torques applied to and the contamination of a second body in the vicinity of the Shuttle due to operation of the Shuttle Reaction Control System engines. This work involves the application of a direct simulation Monte Carlo program for calculating theflow-field properties in this highly expanded region. The approach to be followed is to divide the rocket engine exhaust flow field into two regions. The first region contains the continuum flow regime where conventional methods of flow field analysis are adequate

for calculating the flow field properties. Beyond this intermediate boundary, the continuum methods do not yield reliable results. The second region begins at the boundary of the continuum flow regime and extends as far as required. In this region, the direct simulation Monte Carlo method is used to calculate the flow field properties, based on the boundary conditions calculated from the continuum regime solution. The direct simulation Monte Carlo method is the only computational technique known to efficiently yield reliable results in this region. The improved methods developed under this RTOP will be used by NASA Headquarters, NASA centers such as MSFC and JSC, and NASA contractors having responsibility for payload design, mission planning, and satellite and orbiter contamination assessments.

W82-70674 **906-75-27**
Jet Propulsion Laboratory, Pasadena, Calif.
SENSOR/CONTROL AUGMENTATION OF SHUTTLE REMOTE MANIPULATOR SYSTEM (RMS)
A. K. Bejczy 213-354-4568
(196-60-80; 505-54-85)

The objectives of this RTOP are the development, demonstration, and evaluation of advanced teleoperator techniques and subsystems for Shuttle Remote Manipulator System (RMS) control. They will provide enhanced capabilities for satellite retrieval, maintenance and repair, for in-orbit servicing of reusable vehicles, and for space platform/station assembly such as the Space Operations Center (SOC). The objectives include the development of proximity, force torque and contact sensors with related controls, integrated graphic displays of sensory information, bilateral force reflecting manual controls, and computer based voice command capabilities for controlling both TV cameras/monitors and graphic displays. The final objective is to demonstrate enhanced and smart sensor/control capabilities in the form of protoflight systems/experiments in the CY-84 to 86 time period. The specific FY-82 objectives are: (1) conduct and evaluate force torque control experiments at the JSC Manipulator Development Facility (MDF) using the force torque sensor and display system developed at JPL in FY-80/81; (2) produce both requirements definitions and preliminary designs for protoflight sensor, control, display, and voice command systems, including protoflight experiments definitions; (3) initiate component developments where appropriate. The technical approach is experimental and utilizes the testing capabilities of the JSC MDF. Appropriate sensors, control, displays, algorithms, and related microprocessor based data handling will be developed at JPL based on concepts previously demonstrated in the JPL teleoperator laboratory. New sensor/control capability demonstrations will be conducted using the full scale Shuttle mock up manipulator at the JSC MDF. Existing hardware and facility equipment at JSC will be utilized to the greatest extent possible. The experiments will be defined, performed and evaluated jointly with JSC personnel. The protoflight sensor/control systems/experiments definitions and development will also be done jointly with JSC.

W82-70675 **906-80-00**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED CONCEPTS
Richard C. Kennedy 713-483-3969

Activities covered by this RTOP investigate promising concepts for the accomplishment of functions relevant to Office of Space Transportation System (OSTS) needs. The FY-82 activities will concentrate on identification methods of space debris removal and understanding unique vehicle control techniques. Specific tasks for FY-82 include: (1) the Application of Plasma - Electric Motor Generator Effects to Station Keeping and Attitude Control, and (2) Automated Orbital Debris Removal.

W82-70676 **906-90-00**
Marshall Space Flight Center, Huntsville, Ala.
MEC (MATERIALS EXPERIMENT CARRIER)
Kenneth E. Taylor 203-453-3425

The Materials Experiment Carrier (MEC) is a customized carrier which will accommodate a wide variety of MPS (Materials Processing in Space) Research and commercial payloads, for operation in conjunction with the Power System Platform (PSP). This RTOP provides for continued analysis, concept definition and planning for the MEC. FY-82 work is to further refine concepts for an early MEC to accommodate early MPS payloads, optimize preliminary operational concepts, penetrate specific technology problems, continue cost/schedule analyses, maintain interface analyses, and refine plans for evolution to a full capacity MEC. This work will be accomplished as a continuation of the Phase A study currently in progress. Concepts will be examined and compared to accommodate early MPS payloads for operation with the PSP. Particular efforts will be devoted to requirements and interfaces between the payloads, MEC and the PSP. Concepts and plans will be developed to evolve the early MEC to one capable of accommodating a variety of advanced PSP payloads.

W82-70677 **906-90-03**
Marshall Space Flight Center, Huntsville, Ala.
EXPERIMENTAL GEOSTATIONARY PLATFORM
William T. Carey, Jr. 205-453-3424

The objective of the FY-82 work will be: (1) analyze geostationary missions for the decade of the 1990's and determine the potential role of, optional concepts for, and technology needs for operational geostationary platforms; and (2) define a NASA experimental platform that can pave the way for operational platforms. This work will expand on but not be restricted to the approach taken in previous work sponsored by OSIS, OSTA, and OAST. Phase A studies have shown the benefits of accomplishing future geosynchronous missions on single Shuttle launched geostationary platforms as opposed to many small single purpose satellites. These studies have also pointed to the need for NASA to develop and demonstrate a broad spectrum of technologies for subsequent implementation by the private sector. The FY-82 activity will expand in scope and perspective the analysis of operational missions and potential implementation modes considering mission requirements from the NASA, DOD, and the private sector. The potential role and options for platforms during the 1990's will be ascertained through analysis. Technology needs will be identified. A NASA experimental geostationary platform together with low Earth orbit experiments/demonstrations will be defined. Cost and schedule data will be developed.

W82-70678 **906-90-08**
Marshall Space Flight Center, Huntsville, Ala.
DEPLOYABLE ANTENNA FLIGHT EXPERIMENT
Wilbur E. Thompson 205-453-2796

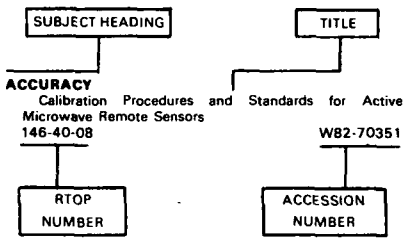
The FY-82 objectives are to complete the system design definition of a large aperture engineering flight test and measurement program to support future space applications which utilize large structures deployed directly from the Shuttle or upper stages. A 50 meter configuration is being defined to provide a reusable test bed facility to evaluate structural and electronic characteristics applicable to future civil and military system designs with 50 to 300 meter apertures. The antenna test article will remain attached to the Shuttle orbiter in low Earth orbit on the initial flight. Phase A contracted studies during FY-77 to FY-79 produced design concepts and flight test program options which allowed initiation of joint NASA/DOD studies in FY-80 to further define a flight experiment and with multi-user test objectives. Parallel system definition of the antenna flight test was continued in FY-81 along with initiation of hardware development for structural ground tests on the large deployable support mast. The FY-82 activities will complete system definitions and provide the remainder of documentation to support development of 50 meter antenna test article and flight test program. Also planned for FY-82 is design, fabrication, and tests on a scale antenna model to aid design and manufacture of a close tolerance 50 meter test article. These accomplishments in FY-82 will retain a NASA, or joint agency option to implement design and development in the FY-83 as shown on the schedule.

SUBJECT INDEX

FISCAL YEAR 1982

RTOP Summary

Typical Subject Index Listing



A title is used to provide a more exact description of the subject matter. The RTOP accession number is used to locate the bibliographic citations and technical summaries in the Summary Section.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

S

T

U

V

W

X

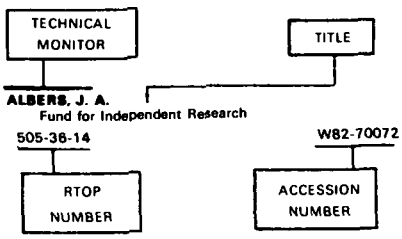
Y

TECHNICAL MONITOR INDEX

FISCAL YEAR 1982

RTOP Summary

Typical Monitor Index Listing



A title is used to provide a more exact description of the subject matter. The RTOP accession number is used to locate the bibliographic citations and technical summaries in the Summary Section.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

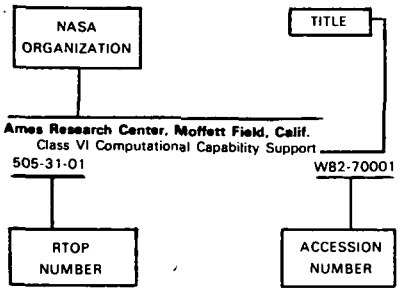
Z

RESPONSIBLE NASA ORGANIZATION INDEX

FISCAL YEAR 1982

RTOP Summary

Typical Responsible NASA Organization Index Listing



Listings in this index are arranged alphabetically by Responsible NASA Organization. The title of the RTOP provides the user with a brief description of the subject matter. The accession number denotes the number by which the citation and the technical summary can be located within the Summary Section. The titles are arranged under each Responsible NASA Organization in ascending accession number order.

A

D

G

J

L

M

N

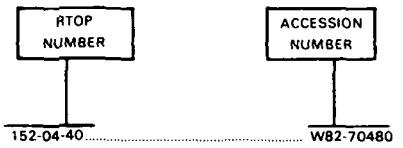
W

RTOP NUMBER INDEX

FISCAL YEAR 1982

RTOP Summary

Typical RTOP Number Index Listing



This section may be used to identify the RTOP accession number of reports covered in this journal. Thus this section of this index may be used to locate the bibliographic citations and technical summaries in the Summary Section. The RTOP numbers are listed in ascending number order.

NASA-Langley, 1982

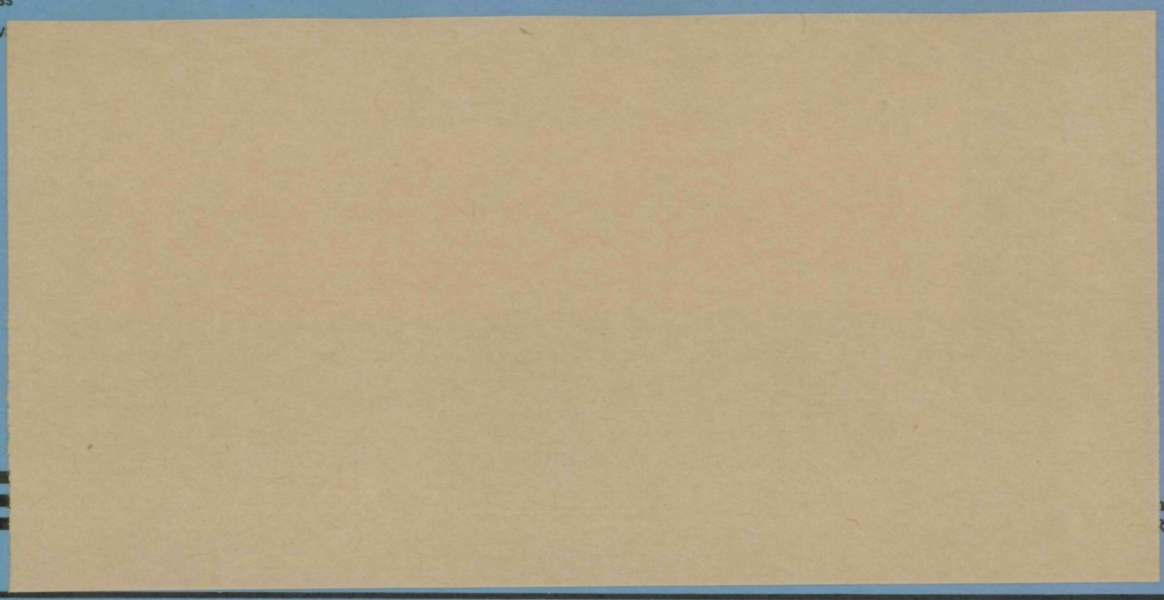
National Aeronautics and
Space Administration

Washington, D.C.
20546

Official Business
Penalty for Priv

THIRD-CLASS BULK RATE

Postage and Fees Paid
National Aeronautics and
Space Administration
NASA-451



NAS

1 158
Return